U.S. DEPARTMENT OF COMMERCE

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The Long-Term Effects of Trace Elements Emitted by Energy Conversion of Lignite Coal
Volume II. Technical Appendices

North Dakota State Dept. of Health
Bismarck

Prepared for

Old West Regional Commission
Billings, MT

Jul 79

U.S. Department of Commerce
National Technical Information Service
NTIS

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THE LONG-TERM EFFECTS OF TRACE ELEMENTS EMITTED BY ENERGY CONVERSION OF LIGNITE COAL

Volume II

Technical Appendices

Prepared For

OLD WEST REGIONAL COMMISSION

July 1979

NORTH DAKOTA STATE DEPARTMENT OF HEALTH

Division of Environmental Research

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A two-year project, concerning effects of selected elements upon the ecosystem surrounding a 675-megawatt coal-fired electrical generating facility, was completed. This project involved the collection of coal, stack fly ash, aerosol, surface water, snow, sediments, soil, and vegetation samples for analysis of element concentrations. A modified atmospheric transport and deposition computer model was developed and used to predict ground-level air concentrations and development of elements from the burning of lignite coal. The results of the project provide evidence of enrichment of certain elements in aerosols, snow, water, soil surface, and vegetation.

KEYWORDS: *Environmental surveys, *Trace elements, *Gas analysis, *Air pollution sampling, *Coal fired power plants, *Air pollution detection.

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THE LONG-TERM EFFECTS OF TRACE ELEMENTS EMITTED BY ENERGY CONVERSION OF LIGNITE COAL

TECHNICAL APPENDICES

A Final Report Prepared For

OLD WEST REGIONAL COMMISSION
Billings, Montana
Grant Number 10773210

By

William W. Morrison, Martin R. Schock
and Gene A. Christianson

July 1979

NORTH DAKOTA STATE DEPARTMENT OF HEALTH
Division of Environmental Research
Bismarck, North Dakota

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APPENDIX A

MATERIALS AND METHODS

1. MILTON R. YOUNG POWER PLANT DESCRIPTION

1.1 Comparison Statistics

Data which describe the construction and production characteristics of the Milton R. Young Power Plant are listed in Table 64.

1.2 Flue-Gas Desulfurization System (SO_2 Scrubber)

1.2.1 Fly Ash/Lime Scrubbing System

The system consists of electrostatic precipitators for particulate removal followed by an absorption spray tower for SO_2 absorption. The absorption system is designed for an L/G of 80 (saturate gas conditions) and 12% solids in the slurry. The recycle tank has a residence time of 8 min and fly ash available from both Units I and II.

Two absorber modules are designed, each to handle a maximum of 56% of boiler flue gas. However, in normal operation the two absorber modules will treat 85% of the design boiler flue gas, with 15% of the flue gas being bypassed to provide about -1 C reheating for the absorber outlet saturated gas. A lime back-up system is provided for absorber pH control.

Design data for the scrubbing system are presented in Table 65.

TABLE 64

MILTON R. YOUNG POWER PLANT DATA

	Unit I	Unit II
Generation Unit	234,550 KW nameplate, General Electric, manufacturer	438,626 KW nameplate, Westinghouse, manufacturer
Boiler	Cyclone - fired Babcock & Wilcox, manufacturer	Cyclone - fired Babcock & Wilcox, manufacturer
No. Coal Conditioners	12 crushers, reduces coal to 0.5 cm in size	7 crushers, reduces coal to 0.5 cm in size
Boiler Rating	1800 psig; 1.6 million lbs steam	2400 psig; 3.05 million lbs steam
Maximum Output	265,000 KW, gross 245,000 KW, net	475,790 KW, gross 437,750 KW, net
Station Power	20,000 Kwh, full load	38,040 Kwh, full load
Type of Fuel	Lignite Coal	Lignite Coal
Fuel Consumption	181,820 kg	340,910 kg
Emission Control Equipment	Hotside ESP, Research Cottrell, Manufacturer 99.-%	Hotside ESP, Wheelabrator Frye, Manufacturer 99.-% Eff. - SO_2, Scrubber Combustion Equipment Manufacturer
Height of Stack	91.5 m	167.7 m
Cooling Water Circulation	446,630 l/min	757,000 l/min
Start-up Date	November 1970	March 1977

TABLE 65

FLY ASH/LIME SCRUBBING SYSTEM DESIGN DATA

1)	Inlet gas conditions: (to booster fans)	
	Total gas flow	2,030,800 acfm
	Temperature	177 C
	Pressure	+ 5.1 cm water
	Fly ash	0.0162 gr/acfm
	SO_2	3.56 lbs/mm BTU
2)	Outlet gas conditions: (total gas flow out of stack)	
	Total gas flow	1,675,600 acfm
	Temperature	73 C
	Pressure at stack inlet	+ 2.29 cm water
	SO_2	1.2 lbs/mm BTU
3)	Gas reheat	-1 C
4)	L/G spray column	303 1/28.3 m^3
5)	System differential pressure	14 cm water (including wash tray)
6)	Percent solids in slurry	12%
7)	Residence time	8 min
8)	pH of slurry	5-6
9)	Slurry liquor velocity	2 m/sec
10)	Absorber saturated gas velocity	2.4 m/sec
11)	Utlization of CaO available in fly ash at pH = 5.5	40%

1.2.3 Process Description

The SO_2 removal system consists of two absorbers in parallel to treat the flue gas from the boiler. Each of the two absorber modules consist of a spray tower, recycle tank, wash tray system and 5 - 25% capacity recycle pumps. The system includes lime slurry preparation equipment, fly ash slurry equipment, wash tray effluent dewatering system, and absorber effluent dewatering system.

The system begins at the takeoff point in the stack breeching after the existing I.D. fans. Eighty-five percent of the boiler flue gas goes through two 50% capacity booster fans (based on 100% of boiler flue gas), with 15% of the boiler flue gas being bypassed to provide approximately -1 C reheat for the absorbers outlet saturated flue gas. The flue gas from the booster fan discharge enters two (2) spray towers. In normal operation, each will handle 42.5% of the boiler flue gas. However, each is designed to handle up to 56% of the total boiler flue gas. The scrubbed flue gas is reheated before entering the stack breeching by means of the bypassed hot flue gas and then discharged to the stack.

The spray tower type of absorber is provided for efficient contact between liquid and gas for optimum SO_2 removal at a low pressure drop. The spray tower is designed for L/G of 80 gal/1000 SCFM saturated. The spray tower is provided with six spray zones. The flue gas passes up through the tower countercurrent to the liquor and then flows through the wash tray, where the 12% entrained slurry is captured and diluted in the tray liquor to about 0.1%. The gas then flows through the mist eliminator for efficient separation of liquid droplets from the flue gas.

A separate recycle tank with 8 min residence time is provided for maximum utilization of alkalinity in the fly ash. Auxiliary makeup lime slurry is added to the recycle tank and the pH is maintained between five and six in the recycle slurry.

The system bleed is taken from the discharge of the recycle pumps to the thickner. Here, clear liquor is removed from the sludge and is brought to the fly ash/lime area; and then back to the absorption system. The thickner, under flow containing 30% solids by weight, will be pumped to two vacuum filters in parallel. The filtrate will combine with the thickner overflow and the 65% solids filter cake is trucked away.

One common lime slurry preparation system is provided with a normal capacity of 2.5 tons per hour. Also a fly ash slurry preparation system is provided with a normal capacity of 25.0 tons per hour.

The system is designed to provide -1 C reheat for the saturated flue gas, bypassing 15% of the total hot gas flow to mix with the flue gas discharged from the absorption towers. To provide the reheat with bypassing 15% of the flue gas, the absorption tower is designed to achieve SO_2 removal efficiency of 77.9% to results in overall SO_2 removal efficiency of 66.3%, which corresponds to 0.55 kg SO_2/MM BTU input.

1.3 Nelson Lake Cooling Water Impoundment Statistics

A dam was constructed on Square Butte Creek for the purpose of collecting spring snowmelt and rainfall runoff as a source of cooling water. No water was discharged downstream from the dam between May 1, 1978, and March 1979. Descriptive data for the dam, watershed, and Nelson Lake are provided in Table 66.

TABLE 66

NELSON LAKE DATA

- Dam Construction: Rolled-earth filled; 16.2 m high; 457 m long.
- Volume of Dam 364,000 m^3 fill
- Service Spillway: Two 66-m conduits containing two 3x3 m gates, one 0.6x1.5 m gate, one 15-m gate.
- Size of Lake: 260 hectares; 11.1 million m^3
- Watershed Area: 351 km^2
- Watershed Runoff: 11.1 million m^3/yr, average

2. COAL SAMPLING

2.1 Baukol-Noonan Incorporated - Center Mine

"Representative" coal from the Center Mine was obtained from the coal crushers at the Milton R. Young Power Plant on two sampling periods in February and April of 1979. A series of point samplings across the exit duct of the crusher was conducted using a 2-m long pneumatic sampling probe with a one-liter sampling jar attached to the probe.

The February collection consisted of sampling 6 of the 7 crushers on Unit I and 6 of the 12 crushers on Unit II. Two liters of coal were collected from each crusher and composited, a total of 12 samples were analyzed. The April collection consisted of taking a one liter sample from each of the 12 crushers on Unit II at the corresponding time that the in-stack sampling was being conducted. A composite consisting of three samplings was analyzed.

2.2 Consolidation Coal Company - Glenharold Mine

Coal from the Glenharold Mine was obtained by sampling 3 of the 12 crushers at the Leland Olds Power Plant. The sampling procedures and the type of apparatus were the same as used at the Milton R. Young Power Plant. A total of three samples were taken for analysis.

2.3 North American Coal Corporation - Indianhead Mine

Coal from the Indianhead Mine was obtained by sampling all four of the coal pulverizers at the United Power Cooperative Power Plant. The same sampling procedures and similar apparatus were used at this plant as were in the previous two. A total of four samples were taken for analysis.

2.4 Knife River Coal Company - South Beulah Mine

Two two-liter samples from the South Beulah Mine were taken from the coal conveyor at the Heskett Power Plant. Two samples were analyzed.

2.5 Coal Drying and Grinding

The samples were dried in a forced-draft oven at 50 C, ground to 100 mesh in a power driven pulverizer at 850 rpm, and redried pending preparation for analysis.

2.6 Analysis

2.6.1 Preparation

Standards, unknowns and Q.A. samples were prepared for x-ray fluorescence analysis by grinding 9.00 grams of coal and 1.00 grams of AR grade boric acid (binding agent) in a rotary swing mill. About two grams of this material was pressed into pellets for XRF analysis and about 10-20 mg was loaded into a 2/5 dram polyethylene vial for neutron activation analysis.

2.6.2 Standards

Comparitive standards were used for both the XRF and NAA. National Bureau of Standards standard coal reference materials SRM 1632A and SRM 1635; Illinois state coal standards C 15263, C 15278, C 16264, C 16317 and C 16408; IAEA soil 5 diluted with cellulose; and combinations of the above were used for standards. Elements such as Ba and Sr not quantified in these standards were estimated from the XRF results based on relative sensitivities.

2.6.3 X-Ray Fluorescence Analysis

Coal pellets were analyzed with an Ortec TEFA 6110 energy dispersive x-ray fluorescence analyzer using three excitation conditions:

1)	Mo Anode	Mo Filter	50 kv
2)	Mo Anode	No Filter	15 kv
3)	W Anode	Cu Filter	35 kv

2.6.4 Neutron Activation Analysis

Each coal specimen, standard and Q.A. sample was individually irradiated in the Reed College reactor for 5 min at a flux of 2×10^{12} n/sec/cm^2. They were then counted using a 15% Ge(Li) γ-ray spectrometer for 5 minutes after a 10 minute decay period.

3. IN-STACK SAMPLING

3.1 General Discussion

The field use of cascade impactors is a difficult task. The accuracy required is more appropriate for a laboratory program than for a field test. There are many places in the operational sequence where errors can occur in spite of a conscientious effort to do a good job.

Two preliminary test runs were conducted prior to the final test. These preliminary runs enabled the testing team to become acclimated to the test facilities and also gather data on stack gas temperature, pressure, moisture, velocity, run time required, etc. These preliminary runs provided information on flow rates and nozzle size to maintain isokinetic sampling during the final test.

All tests were performed at the 122-meter level on Unit II of the Milton R. Young Power Plant.

The impactor used in these tests was the Pilat (University of Washington) Mark III Source Test Cascade Impactor. Some of the features of this impactor are listed below.

1) Separates 0.2 to 20 m diameter solid or liquid aerosol particles into seven size classifications for later weighing and/or chemical analysis.

2) In stack sampling and particle sizing minimizes problems of losses of particles to the tubing walls and of water vapor condensation.

3) Isokinetic sampling for a true representative particle sample.

4) Separate particle collection plates which allow for obtaining multiple samples with a single cascade impactor unit.

5) Lightweight disposable collection plate inserts of stainless steel foil allow improved weighing precision and reduces need for many sets of collection plates.

6) Built-in 47-mm diameter filter holders.

7) Collection plates designed for minimal particle sample handling loss.

8) Sample at 0.1 to 1.2 acfm gas flow rate.

The sampling device used was a Nutech Corporation EPA-method-five sampling train with the University of Washington Mark III Cascade Impactor mounted on the end of a heated stainless steel probe, the sample box containing the impingers, an umbilical cord, and the meter control box.

The final test was conducted in April of 1979. It consisted of two separate runs of 80 and 100 min, respectively.

3.2 Pre-Test Preparation

One of the biggest problems in trace metal sampling and analysis is the problem of contamination. The steps taken to avoid this problem will not be specifically enumerated; except to note that every possible means was taken to avoid contamination.

Prior to the test all components of the sampling train were thoroughly cleaned. The impactor jet stages were cleaned with acetone in an ultrasonic cleaner. A complete set of glassware was used for each run, therefore greatly reducing the possibility of cross-contamination between runs. All glassware was acid washed and rinsed with copious amounts of high purity water.

The final filter plus the impaction substrates (filters) was laminated Teflon, manufactured by the GHIA Corp. of Pleasanton, California. The filters were oven dried at 100 C for 24 hr and then stored in a desiccator.

The day before the test the filters were weighed with an accuracy of ± 0.1 mg, placed in marked petri dishes and stored in a desiccator until the impactor was loaded.

The set of impingers consisted of five Greenburg-Smith impingers in series filled with 250 ml of 3M H_2O_2 in the first impinger, 125 ml of 0.2M $(NH_4)_2S_2O_8$ plus 125 ml of 0.02M $AgNO_3$ in the next three impingers, and 250 g of silica gel in the last impinger.

The 3M H_2O_2 passes Hg vapor but removes the SO_2 to prevent depletion of the Ag catalyzed $(NH_4)_2S_2O_8$ solution. The persulfate solution is specifically designed to remove Hg, but will collect any Se, Sb, As or Pb that passes through the peroxide impinger. In all cases, the volatile species are oxidized in the H_2O_2 or $(NH_4)_2S_2O_8$ and are effectively scrubbed from the gas stream.

Since $(NH_4)_2S_2O_8$ is not stable in solution, it, plus all other chemicals, was made up in the laboratory the morning of the test and dispensed into two complete sets of impingers.

A good portion of the sampling train was assembled in the laboratory the morning of the test. Upon arrival at the testing site, Teflon-thread sealant tape was applied to all threaded parts of the train.

3.3 Test Procedures

The following information and data is gathered during the test.

- Date
- Time
- Impactor Type and Identification Number
- Operator
- Port Number/Sampling Location
- Ambient Temperature
- Ambient Pressure
- Impactor Orientation
- Number of Traverse Points
- Stack Pressure
- Stack Temperature
- Nozzle Diameter/Type
- Probe Depth
- Stack Pitot Tube Delta P/Stack Gas Velocity
- Desired Impactor Flow Rate for Isokinetic Sampling
- Metering Orifice Identification Number
- Metering Orifice Delta P
- Impactor Temperature
- Impactor Pre-heat Time
- Substrate Set Identification
- Test Start/End Time: Duration of Test
- Gas Meter Start/End Readings: Gas Meter Volume
- Agreement Between Meter and Orifice
- Volume of Condensible H_2O in Flue Gas
- Gas Meter Temperature
- Leak Check/Start-End
- Plant Operating Characteristics

Upon completion of the first test run, the impactor was removed from the probe, placed in a Nalglene zip-lock polyethylene bag and taken to the stable environment of the Plant's laboratory for break-down and reloading. At the completion of the second test run, the impactor was returned to the NDSDH Laboratory for unloading.

3.4 Post-Test Procedures

The impingers were returned to the NDSDH laboratory and the volumes of each of the solutions were measured using a clean graduated cylinder, and the solutions were then returned to their original containers. It is desirable to begin with the last impinger solution in the sampling train and to work toward the first solution which has the greatest concentration of trapped species. The graduated cylinder was rinsed between each solution measurement, and cleaned with nitric acid between series of solutions.

The collected (filters) were desiccated for 48 hr and then weighed. The particle weights were recorded and used to calculate size distributions, mass concentrations and other pertinent data used in the final analysis.

4. AMBIENT AEROSOL SAMPLING

4.1 Description of the Stacked Filter Unit

A modified Research Appliance Company, total particulate membrane sampler with the attached SFU was mounted on 4-m platforms (   ). This continuous sampler features rainproof protection for the filter media, motor, and pump. The unit consists of a 1/2-hp, oil-less carbon vane pump, magnehelic differential pressure gauge, push-to-test valve that is used to read differential flow rates on the gauge and to zero the gauge when the unit is operating.

The aerosol particles were collected on 47-mm diameter 12-μm and 0.4-μm Nuclepore filter using Nuclepore aerosol holders and multiple holder adapter.

Nuclepore filters were chosen because they are flexible, will not crack, and are not easily broken. They have a very low constant tare weight, varying no more than ±5%. Nuclepore filters are non-hygroscopic; thus, they are particularly well suited for gravimetric analysis. These filters will not pick up moisture from the air during weighing.

4.2 Operation of the Stacked Filter Unit

The sampling period was from June through October on a 24-hour 7-day a week basis. During the initial start-up of the sampling network, volume flow rates of the vacuum pumps were calibrated at each site daily with a dry test flow meter.

The filters were weighed to a precision of 10 μg using an electrobalance. Immediately before the filters were weighed, they were passed in front of a ^{210}Po radioactive source to remove any electrostatic charge. The filters were the placed in 47-mm petri dishes with tight fitting lids. The weight, site number, and filter pore size were recorded on the dish before delivery to the network operator. Each site had two SFU's so that the operator could load and unload the complete unit at his headquarters to minimize contamination and other handling problems. Upon removal from the SFU, each filter was placed in its original container and placed with its lid ajar in a desiccator to dry for 48 hr. The filters were returned to the laboratory for weighing once each week.

4.2.1 Selected Samples for Analyses

Wind data from the wind sensors located at Halliday, Stanton, and Bismarck were used to identify days when one of the sites, A1-A4, would likely have been downstream from the facility stack during a portion of the 24-hr sampling day. The wind sensors were operated by the NDSDH under its Air Quality Program.

Filters for element analysis were selected from days when wind data indicated a site was downstream of the facility stacks for 12-hr or more. Further, if the wind direction reversed during such a day so that the stack plumes were potentially directed over upstream sites, the day was discarded for analysis. This procedure resulted in a selection of those sampling days listed in Appendix D for filter analysis of element concentrations.

4.2.2 Particulate Mass Loading

The major source of suspended atmospheric particulates in North Dakota occurs from wind blow dusts and agricultural activities. During the climatically drier season of July and August, the concentration (μm/m^3) of suspended dust reaches maximum values in an annual cycle.

Clogging of the 0.4- m Nuclepore filter can occur with a mass loading of 50 μg/cm^2 of filter surface area (1). Therefore, a sample (comprising both the 0.4 and 12-μm filters) was rejected from further statistical analyses if mass loading on the 0.4-μm filter exceeded 870 μg (50 μg/cm^2). Since the loading level for clogging of the 12-μm filter was not known, samples with a loading of 1000 μg on the 12-μm filter were also rejected from further statistical analyses.

4.2.3 Volume Flow Rate

The average volume flow during a 24-hr sample ranged from 13 to 51 l/min. A scatter diagram analysis for the selected samples

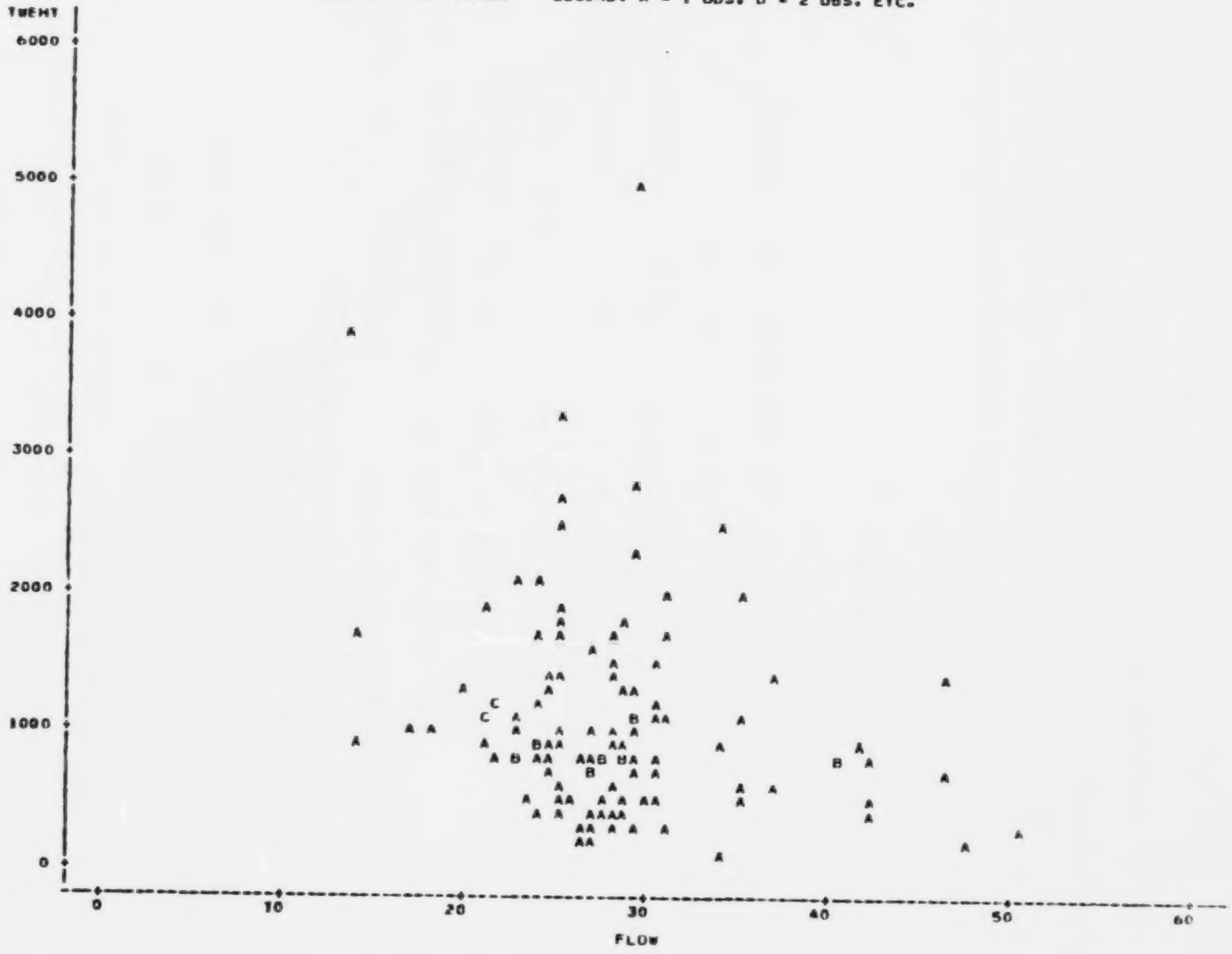
(Section 4.2.1) of the total particulate loading from both the 0.4 and 12-μm filters versus the average flow is shown in Figure 52.

Since the effective cut-off diameter of the filters is dependent upon the face velocity of air passing through the filters, the air flow rate should not change (decrease) by more than 20% during the sampling day (1). However, samples for which the change was more than 20% were not rejected from statistical analyses due to the mechanical insensitivity of the flow by-pass valve on the sampling device.

The effective cut-off diameter decreases rapidly with excessive face velocities (1). Samples were rejected from statistical analysis when the face velocity exceeded 30 cm/sec (average volume flow rate of 31 l/min).

AEROSOL DATA

PLOT OF TWEHT*FLOW LEGEND: A = 1 OBS, B = 2 OBS, ETC.



5. ANALYTICAL PROCEDURES FOR THE ANALYSIS OF COAL, IN-STACK PARTICULATE, AND AMBIENT AEROSOL SAMPLES

Coal, in-stack particulate, and the aerosol filters were analyzed by the Oregon Graduate Center and NEA Laboratories.

The analytical procedures included Energy Dispersive X-ray Fluoroescence (EDXRF) using an Ortec TEFA 6110 and Instrumental Neutron Activation Analysis (INAA). Figure 54 and 54 is a flow diagram depicting the steps and elements included in the analyses.

5.1 EDXRF - General Discussion

Principle: Atoms in the sample are excited from their ground state to higher energy levels by X-radiation from an X-ray tube. These excited atoms emit discrete energy X-ray as they return to their normal ground state energy level. The energy of these emitted X-rays is characteristic of the emitting element and is used to qualitatively identify the element while the number of observed X-rays, which is proportional to the number of atoms, is used to quantitatively determine a specific element's concentration through a direct comparison with standards.

Interferences: There are numerous potential spectral interferences possible with EDXRF because of its poor resolution relative to the number and spacing of X-ray lines. Table 68 lists those elements and their possible sources of significant interferences. In this particular application, spectral interferences will be

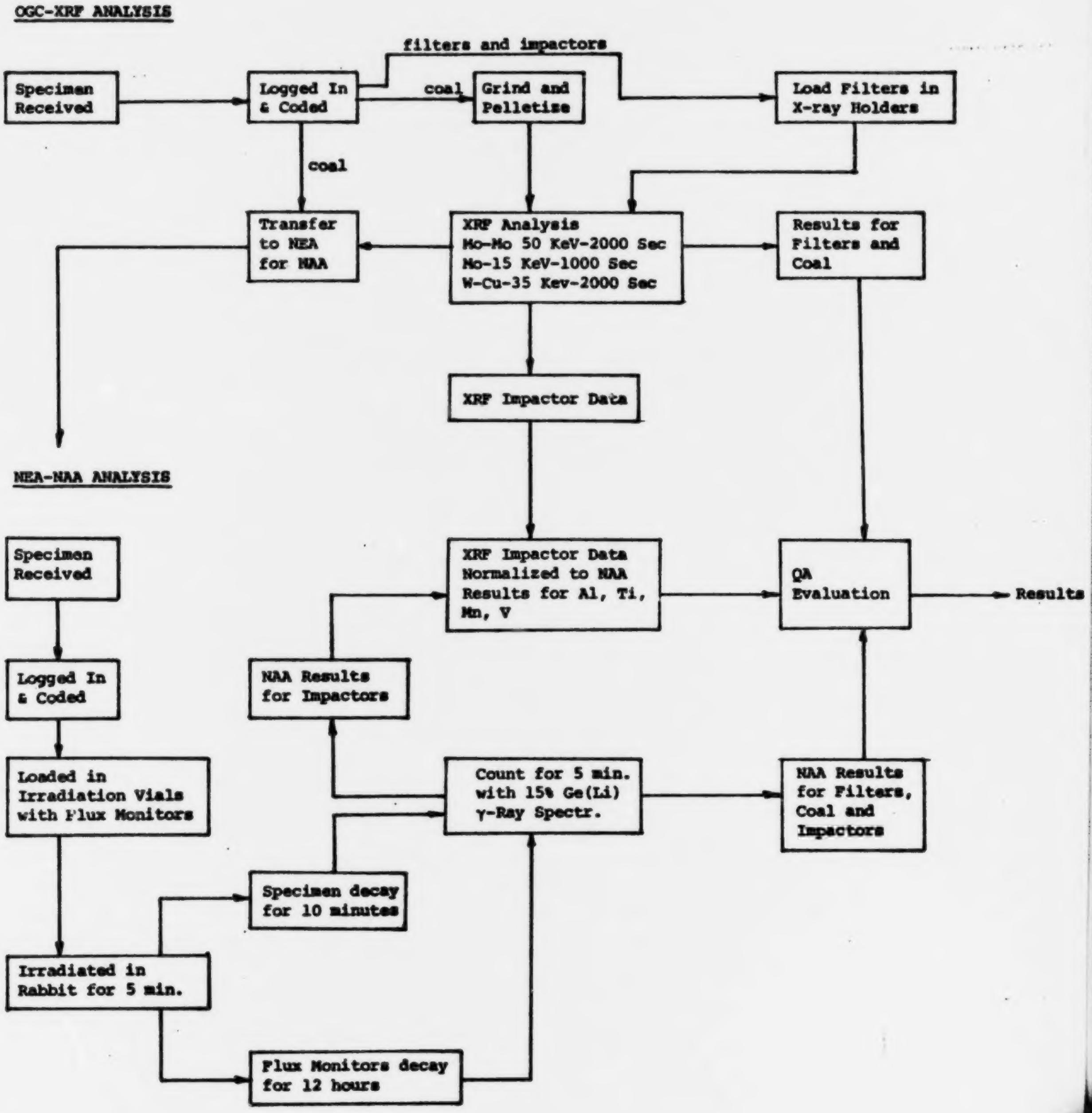

OGC-XRF ANALYSIS
Specimen Received
Logged In & Coded
filters and impactors
coal
Grind and Pelletize
Load Filters in X-ray Holders
coal
Transfer to NEA for NAA
XRF Analysis
Mo-Mo 50 KeV-2000 Sec
Mo-15 KeV-1000 Sec
W-Cu-35 Kev-2000 Sec
Results for Filters and Coal
XRF Impactor Data
NEA-NAA ANALYSIS
Specimen Received
XRF Impactor Data Normalized to NAA Results for Al, Ti, Mn, V
QA Evaluation
Results
Logged In & Coded
NAA Results for Impactors
Loaded in Irradiation Vials with Flux Monitors
Count for 5 min. with 15% Ge(Li) γ-Ray Spectr.
NAA Results for Filters, Coal and Impactors
Specimen decay for 10 minutes
Irradiated in Rabbit for 5 min.
Flux Monitors decay for 12 hours

Figure 53. Analytical scheme for elemental analysis of coal, aerosol, and stack samples.

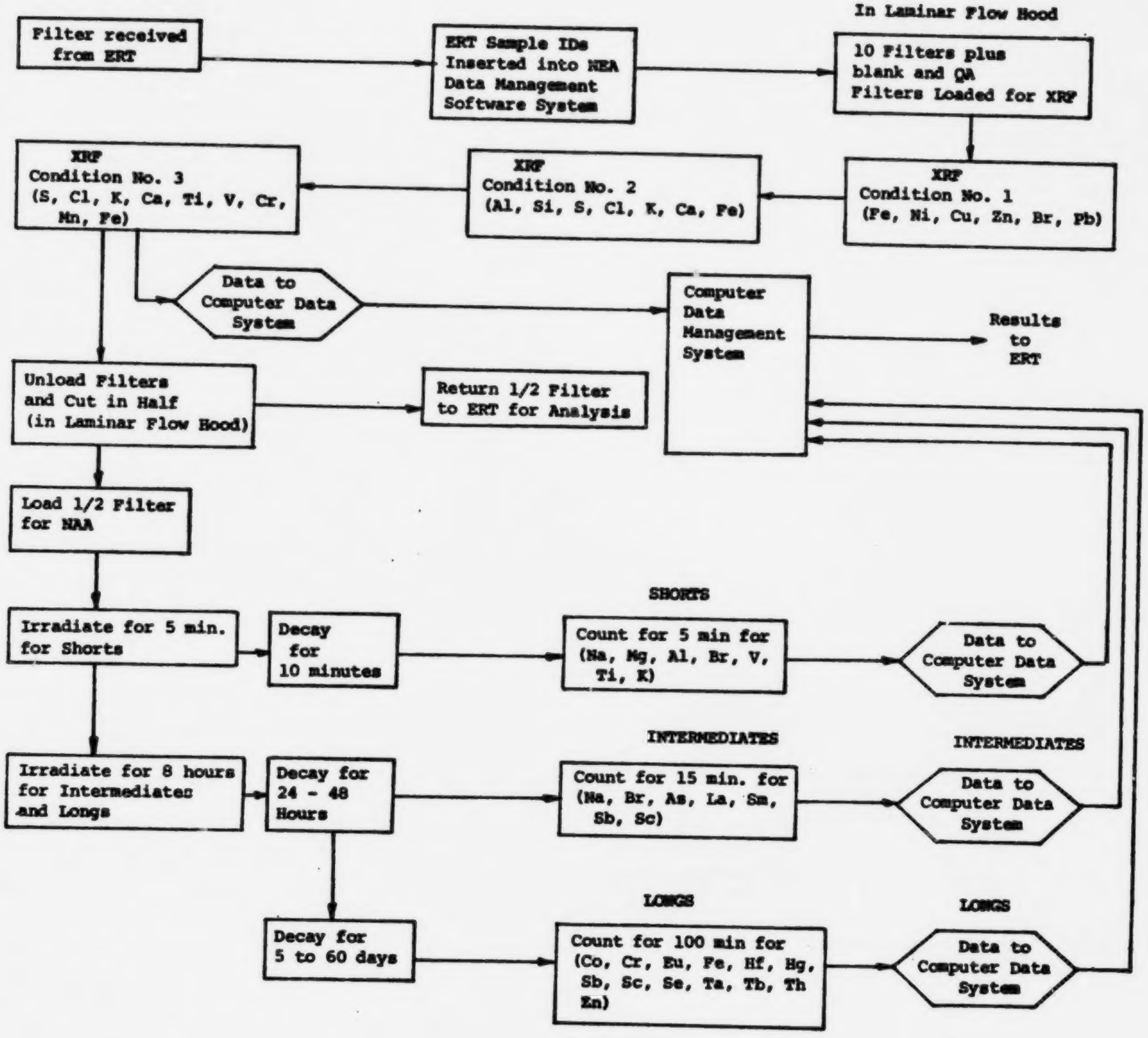

In Laminar Flow Hood
Filter received from ERT
ERT Sample IDs Inserted into NEA Data Management Software System
10 Filters plus blank and QA Filters Loaded for XRF
XRF Condition No. 3 (S, Cl, K, Ca, Ti, V, Cr, Mn, Fe)
XRF Condition No. 2 (Al, Si, S, Cl, K, Ca, Fe)
XRF Condition No. 1 (Fe, Ni, Cu, Zn, Br, Pb)
Data to Computer Data System
Computer Data Management System
Results to ERT
Unload Filters and Cut in Half (in Laminar Flow Hood)
Return 1/2 Filter to ERT for Analysis
Load 1/2 Filter for NAA
SHORTS
Irradiate for 5 min. for Shorts
Decay for 10 minutes
Count for 5 min for (Na, Mg, Al, Br, V, Ti, K)
Data to Computer Data System
INTERMEDIATES
INTERMEDIATES
Irradiate for 8 hours for Intermediates and Longs
Decay for 24 - 48 Hours
Count for 15 min. for (Na, Br, As, La, Sm, Sb, Sc)
Data to Computer Data System
LONGS
LONGS
Decay for 5 to 60 days
Count for 100 min for (Co, Cr, Eu, Fe, Hf, Hg, Sb, Sc, Se, Ta, Tb, Th Zn)
Data to Computer Data System

Figure 54. Flow diagram for additional NAA.

corrected for by substracting the fraction of counts due to element i which interfere with the counts for element j. These fractions are experimentally determined as described in standard operating procedures. Minimum Detectable Concentrations (MDC) on Nuclepore Filters under standard excitation conditions and analysis time listed in Table 67 are presented in Table 68. They are determined by the formula:

$$MDC_i = 3 \sqrt{\frac{B_i}{N_i}} \; C_i$$

where

MDC_i = the minimum detectable concentration of element i in μg/cm^2

C_i = known concentration of element i on Nuclepore filter in μg/cm^2

N_i = net number of counts measured when element i is analyzed under standard conditions

B_i = number of background counts subtracted from total counts in region of interest i to obtain N_i.

Background Subtraction: Most of the background counts in a region of interest are due to the scattering of primary radiation from the specimen. The amount of this scattering depends upon the mass of the specimen presented to the primary exicitation beam. A blank filter is run under each standard condition prior to routine analysis and the background in each region of interest is linearly related to a high energy incoherent scatter peak due to the primary radiation. The same scatter peak is monitored on all loaded specimens and the linear relationship is used to estimate the background in the region of interest.

TABLE 67

EXCITATION CONDITIONS AND REGIONS OF INTEREST

EXCITATION CONDITIONS 1
ANODE: MO
FILTER: MO
VOLTAGE: 50 KV
CURRENT: 2000A
TIME: 1000 SEC
ENERGY RANGE: 40 KV

SPECTRUM ROI REGIONS

REGION	START	END
1	156	164
2	183	191
3	197	205
4	212	220
5	258	269
6	276	284
7	292	302
8	310	320
9	412	426
10	568	584
11	790	808

EXCITATION CONDITIONS 2
ANODE: MO
FILTER: NONE
VOLTAGE: 15 KV
CURRENT: 2000A
TIME: 400 SEC
ENERGY RANGE: 10 KV

SPECTRUM ROI REGIONS

REGION	START	END
1	141	155
2	167	181
3	224	240
4	324	338
5	365	376
6	631	649

EXCITATION CONDITIONS 3
ANODE: W
FILTER: CU
VOLTAGE: 35 KV
CURRENT: 2000A
TIME: 800 SEC
ENERGY RANGE: 20 KV

SPECTRUM ROI REGIONS

REGION	START	END
1	112	120
2	127	135
3	162	170
4	180	190
5	221	231
6	243	253
7	266	276
8	290	300
9	313	326
10	520	534
11	585	605
12	620	640

TABLE 68

SOURCES OF SIGNIFICANT INTERFERENCE WITH ECXRF

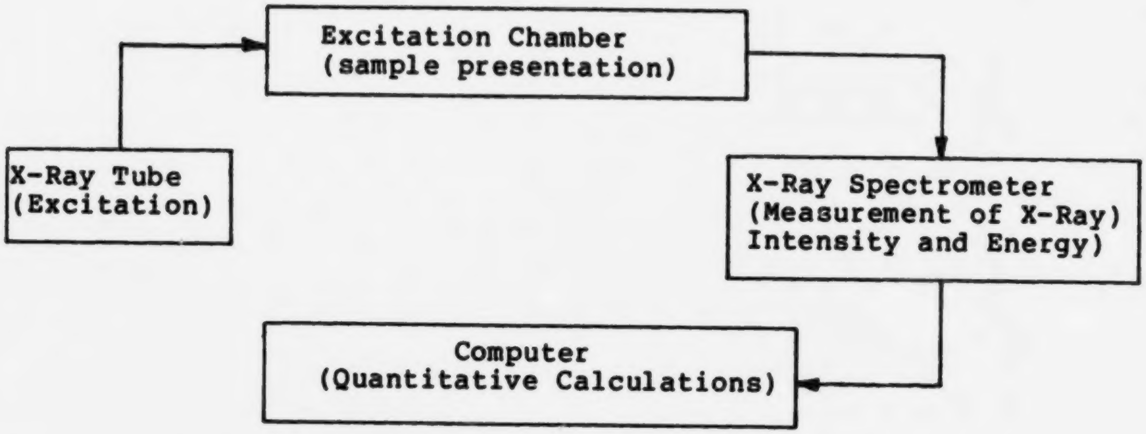
Element	µg/cm^2		µg/cm^2		Non-Interference 1/ MD.C., µg/cm^2			Analyte Line	Corrected for spectral interference from
	Typical	Range	Typical	Range	Cond. 1	Cond. 2	Cond. 3		
Al	4.000	.140-23.0	8.0	.28-46.0		.035		K	Br L
Si	10.0	4.2-115	20.0	8.4-230		.027		K	
S	5.0	1.4-32.2	10.0	2.8-34.4		.287	.094	K	Pb M
Cl	0.50	.070-23.0	1.0	.14-46.0			.063	K	S K , Pb M
K	2.0	.21	4.0	.42-23.0		.046	.022	K	
Ca	5.5	.49 -64.4	11.0	.98-128		.043	.022	K	K K
Ti	0.30	.007-16.1	0.60	.014-32.2			.055	K	Ba L
V	.050	.0007-6.4	.1	.0014-12.8			.004	K	Ba L
Cr	.020	.0017-.736	.40	.0034-1.48			.004	K	Ti K
Mn	.100	.007-4.6	.20	.014-9.2			.005	K	V K
Fe	4.0	.28-46.0	8.0	.56-92.0	.011		.007	K	Cr K
Ni	.032	.0007-.92	.064	.0014-1.84	.005			K	Mn K
Cu	.30	.014-12.0	.60	.028-24.0	.006			K	Ni K
Zn	.60	.014-23.0	1.2	.028-46.0	.005			K	Cu K
As	.016	.002-.200	.032	.004-40	.005		.008	K	Pb L
Se	.002	.0001-.010	.004	.0002-.02	.006			K	Pb Ln
Br	.140	.0035-2.3	.280	.007-4.6	.008		.011	K	
Cd	.002	.0003-.055	.004	.0006-.110	.050			K	
Ba	.08	.04-.10	.16	.08-.20	.360			K	
Pb	1.20	.10-8.0	2.40	.20-16.0	.021		.031	K	

1/ Conditions 1, 2, and 3 are identified in Table 67.

Precision and Accuracy: Count variation of less than 1% have been observed over 24 hr periods. All results are reproducible to within 1% when counting statistics are not the primary source of uncertainty. The accuracy in terms of the deposit on the filter is primarily limited by the uncertainties in the values for the standard values which may be as high as 10 to 15% but are typically 5%. Errors in the absorption correction for the low atomic number elements ($Z<20$) may approach the same order or magnitude as sampling error.

5.1.1 Apparatus

The X-ray fluoroescence analyzer used for these analysis is an Ortect TEFA 6110 system. A block diagram of its major components is shown below:


Excitation Chamber
(sample presentation)
X-Ray Tube
(Excitation)
X-Ray Spectrometer
(Measurement of X-Ray)
Intensity and Energy)
Computer
(Quantitative Calculations)

The primary function of the excitation system is to generate inner shell electron vacancies which result in the emission of

X-rays characteristic of the sample elements. The TEFA system has available Mo and W anode tubes and Mo and Cu primary X-ray filters can be used to obtain monochromatic excitation.

Air filters are presented to the excitation radiation and spectrometer in an evacuated excitation chamber.

The X-ray spectrometer consists of Si(Li) X-ray detector amplifier and pulse height analyzer which measures the energy and intensity of the characteristic X-ray generated in the above excitation procedure.

5.1.2 Calibration

External Standards: Columbia Scientific Industries multidot solution standards on Millipore filters are used. The instrument is calibrated with single element standards and with multielement solution deposited standards. The standards are kept permanently mounted in clean, closed containers and are labeled with an identification code. The surface concentration relevant to a specific excitation standard is listed in Table 69.

Internal Standards: The results of the NAA are used to normalize the relative efficiency calibration curves for those cases where uniform deposits are not obtained.

TABLE 69

CALIBRATION STANDARDS

SURFACE CONCENTARTIONS

Standard	Condition 1		Condition 2		Condition 3	
ID	Mneumonic	$\mu g/cm^2$	Mneumonic	$\mu g/cm^2$	Mneumonic	$\mu g/cm^2$
SS001	FE NI AN CD uu		FE uu		TI CR PF uu	
SS002	CU PB uu		uu		Vu MN uu	
SS004	uu		AL SI uu		uu	
SS003	uu		uu		uu	
SS005	uu		Su		Su uu	
SS007	uu		CA uu		CA uu	
SS008	BR uu		Ku uu		Ku BR	
SS010	AS uu		uu		AS uu	
SS011	SF uu		uu		uu uu	
SS012	BA uu		uu		uu	
SS013	uu		uu		CL uu	

u = space

All $\mu g/cm^2$ values are ±5% by manufacturer's specifications.

5.1.3 Calculations

For conventional aerosol deposits on air filters, the number of X-ray photon events from element i measured by the Si(Li) detector, N_i, is proportional to the mass of element i, M_i, times an attentuation factor, A_i, which takes into consideration the absorption of the primary excitation and the characteristic X-rays in the specimen.

$$N_i = K_i M_i A_i$$

where K is a proportionality constant, an unknown mass, M_i, may be determined by comparison of the number of events measured when it is irradiated to the number, N_i^S obtained from a known mass, M_i^S, if the respective absorption coefficients A_i and A_i, are known.

$$M_i = \frac{N_i A_i^S}{N_i^S A_i} M_i^S \qquad (2)$$

For elements with atomic numbers >20, $A_i \sim 1$ for both standard and sample in the case of thin aerosol deposits and can be ignored. Thus, 2>20,

$$M_i = \frac{N_i}{N_i^S} M_i^S \qquad (3)$$

The regions of interest in the 1024 channel spectrum for each element are listed in Table 68. Ni + N_i^S are the Net count in the spectrum region of interest i which are obtained after subtracting the bremsstrahlung background counts scattered from the primary beam by the filter and any contributions to the region by elements in other regions of the spectrum (Table 68 points out the importance interferences).

Background subtraction is accomplished by obtaining a spectrum from a blank Nuclepore filter. The Mo Kα scatter peak count is monitored for all specimens and its ratio with that of the blank is used to normalize the background in each region.

After background subtraction, spectral interferences are eliminated by determining the fraction of the Net counts in region of interest j contribute to the counts in region of interest i, A_{ij}, from spectra of non-interfering elements. Thus,

$$N_{Ti} = N_{Ai} - \sum_{j=1}^{n} A_{ij}N_{Tj}, \qquad \begin{array}{l} i=1 \\ n=\text{number of elements} \end{array} \qquad (4)$$

where the A subscript designates the actual number of net counts including interferences and T subscript indicates the true number after intereferences have been eliminated. In most cases, only one interfering line is present as indicated in Table 5.1.1.

The uncertainty in the calculation is estimated by summing in quadrature the uncertainties in each of the parameters of eq. (3) for $2<20$.

$$\frac{\theta_{M_i}}{M_i} = \left(\frac{\theta^{2s}_{N_i}}{N_i^{2}} + \frac{\theta^{2s}_{N_i}}{N_i^{s2}} + \frac{\theta^{2s}_{M_i}}{N_i^{s2}} \right)^{.5} \qquad (5)$$

where $\frac{\theta_{M_i^s}}{M_i^s} = 0.5$ from manufacturers specifications and

$$\frac{\theta_{N_i}}{N_i} = \sqrt{\frac{N_i + 2B_i}{N_i}}$$

where Bi is the background contribution in region i.

5.1.4 Quality Control

1) Filters remained in covered plastic petri dishes until transferred to the filter holders. All holders were cleaned between each analysis.

2) Overall quality control was maintained by analyzing one standard multielement filter for every 10 air filters analyzed and assuring that the measured, were comparable to the actual values.

5.1.5 Quality Assurance

1) Portions of each filter identified for intensive chemical analysis were anlayzed by INAA and ion chromatography in addition to the EDXRF analysis. Those elements measured

by EDXRF, which were also measured by other methods, were used as an internal check on the quality of the results.

2) Selected non-intensive day filters were analyzed by EDXRF at OGC and sent to outside laboratories (Battell-Northwest and EPA-RTP) for EDXRF procedure used at OGC.

3) USGS and NBS standards were analyzed as unknown with each group as a check on the analysis.

4) The same samples were analyzed by XRF for some of the same elements as obtained by INAA. Bromine, for example, was measured with high precision with both methods and should service as an excellent cross check.

5) Interlaboratory comparisons with BNW and EPA served to check the overall analytical procedure.

5.2 Neutron Activation Analysis - General Discussion

Principle: The elements of a specimen when placed in a neutron flux from a nuclear reactor will absorb neutrons and undergo nuclear transmutatious forming radioactive elements which emit radiations characteristic of that specific radionuclide. Since the number of these radioactive elements formed is proportional to the number of original stable element atoms present, a measure of the number of specific radionuclide's raditions is an indirect quantitative measure of the stable elements concentration. A simple comparison of the specific radioactivity produced from a standard and an unknown is usually adequate for a quantitative analysis.

Analytical Problem: Neutron activation analysis (short irradiations) was used to measure nine elements (Na, Mg, Al, Cl, Ti, V, Mn, Br and Ba) in Nuclepore air filters. The sensitivity of this method is compared with typical concentration ranges in Table 69. The Minimum Detectable Concentrations, MDCs listed are 3 sigma limits and allowed the determination of elements at those concentrations to about ±30%. Although the lower limit of the typical urban concentration levels is close to the NAA MDC, the average value in the Portland area was considerably greater as indicated.

Interferences: Neutron Activation interferences take the form of (1) competing reactions and (2) spectral interferences; the latter of which is negligible when using Ge(Li) gamma-ray spectrometers. Competing reactions such as n,p and n,α reactions, as potential problems, were considered in the calculations or minimized by using standards with a composition similar to the sampled aerosol.

5.2.1 Apparatus

Reactor: Washington State University Triga reactor was used. This rabbit facility (a pneumatic transfer device) irradiates

TABLE 69

COMPARISON OF NAA SENSITIVITY VERSUS TYPICAL URBAN CONCENTRATION RANGES
(ng/m^3)

Element	NAA MDC(1)	Urban Range (2)	Portland Air.(3)
Na	100	200-10,000	
Mg	500	700- 7,000	
Al	40	200-10,000	
Cl	200	100-10,000	1,600
Ti	50	10- 7,000	
V	1	1- 2,000	40
Mn	5	1- 2,000	
Br	10	70- 1,000	
Ba	10	50- 100	
K		300- 5,000	

---

(1) Based on the analysis of 1/4 filter representing at a minimum of about 5 m^3.

(2) "Urban Aerosol Trace Element Ranges and Typical Values", Cooper 1973.

(3) "Impact of Emissions..." Baum and Pitter, 1976.

samples in the G4 position at the thermal neutron flux of 5.3×10^{12} n/cm^2/sec with a Cd ratio of 4.6.

Gamma-Ray Spectrometer: A Ge(Li) gamma-ray spectrometer set to cover the energy range from 0 to 2000 keV was used.

5.2.2 Reagents and Materials

Filter Specimen Envelopes: 0.55 mil polyethylene (Glad Wrap^R) from Union Carbide has been shown to have acceptable blank levels for this application. Each new batch of Glad Wrap was tested for blank levels before use.

Standards: Gravimetrically prepared solutions of $MgCl_2$ and KBr plus Soil-5, BCR-1 or ARCHO-1 geological materials were used as calibration standards. Quality assurance standards consisted of NBS orchard leaf, NBS Bovine Liver, USGS BCR-1, Soil-5 and ARCHO-1.

Possible Sources of Contamination:

1) Hands - source of Na^{24} contamination
2) Forceps - cross contamination if forceps aren't wiped before and after each sample. If analyzing for Al, teflon forceps must be used to prevent Al^{28} contamination from forceps.
3) Scissors
4) Environment - Laminar flow hood, balance and all other work areas must be clean before sample preparation begins.
5) Any object or material which may come into contact with the samples prior to irradiation, and any tools used during irradiation and transfer may also contribute.

5.2.3 Procedures

The procedures of the neutron activation analysis are described in flow diagrams in Figures 55, 56, 57, and 58.

5.2.4 Calculations

The activity (i.e., number of radionuclide atoms) A_i, of element i upon removal from the reactor after t minutes of irradiation is

$$(1) \quad A_i = k_i Ø \, m_i \, (1 - e^{-\lambda_i t})$$

where k_i is a proportionality constant, m_i is the mass of element i in the sample, λ_i is the decay constant of radionuclide i, and Ø is the average neutron flux encountered by the sample during irradiation.

After removal from the reactor, the sample was allowed to decay for t_1 minutes, then counted until t_2 minutes. The number of counts (normalized to a common shelf) detected, N_i, is proportional to the number of radionuclide i atoms decaying in the interval between t_1 and t_2, the original activity, and the fraction* of the total counting interval actually processed by the Multichannel analyzer,

---

* In reality this fraction does not remain constant throughout the "real time" counting interval, $t_2 - t_1$. However, computer simulations indicate that less than 1% for the shortest lived element, Al, when $\frac{L}{t_2 - t_1} <.875$ for typical aerosol samples. By limiting the initial dead time to <23% when counting starts, this condition is always met.

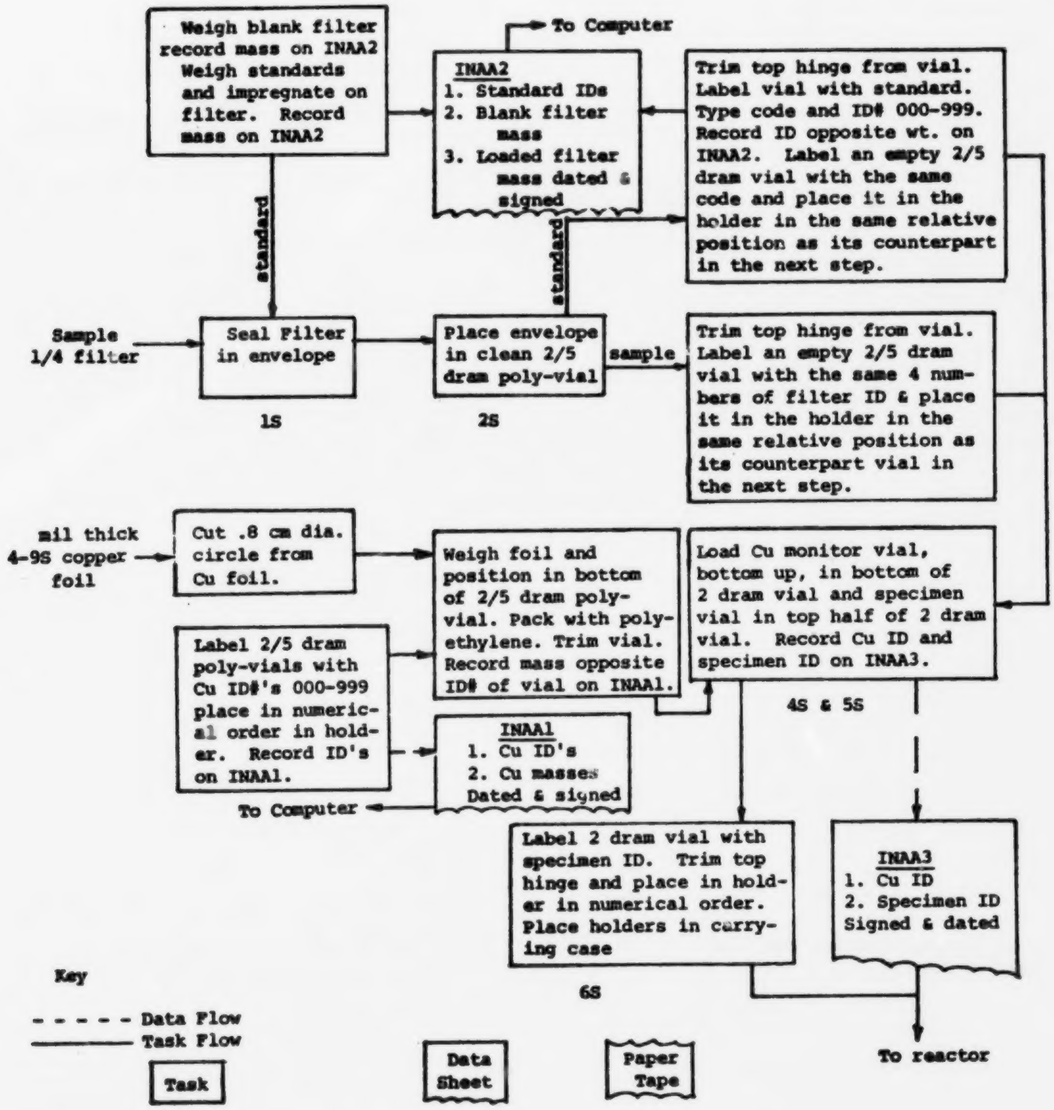
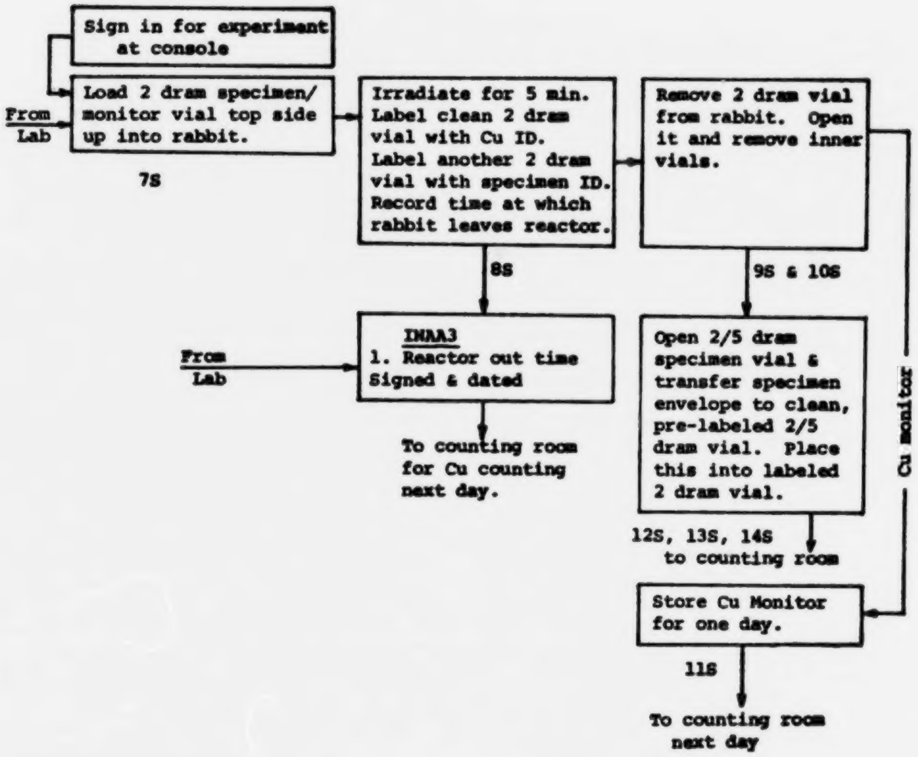

Weigh blank filter record mass on INAA2 Weigh standards and impregnate on filter. Record mass on INAA2
To Computer
INAA2
1. Standard IDs
2. Blank filter mass
3. Loaded filter mass dated & signed
Trim top hinge from vial. Label vial with standard. Type code and ID# 000-999. Record ID opposite wt. on INAA2. Label an empty 2/5 dram vial with the same code and place it in the holder in the same relative position as its counterpart in the next step.
standard
standard
Sample 1/4 filter
Seal Filter in envelope
Place envelope in clean 2/5 dram poly-vial
sample
Trim top hinge from vial. Label an empty 2/5 dram vial with the same 4 numbers of filter ID & place it in the holder in the same relative position as its counterpart vial in the next step.
1S
2S
mil thick 4-9S copper foil
Cut .8 cm dia. circle from Cu foil.
Weigh foil and position in bottom of 2/5 dram poly-vial. Pack with polyethylene. Trim vial. Record mass opposite ID# of vial on INAA1.
Load Cu monitor vial, bottom up, in bottom of 2 dram vial and specimen vial in top half of 2 dram vial. Record Cu ID and specimen ID on INAA3.
Label 2/5 dram poly-vials with Cu ID#'s 000-999 place in numerical order in holder. Record ID's on INAA1.
INAA1
1. Cu ID's
2. Cu masses
Dated & signed
4S & 5S
To Computer
Label 2 dram vial with specimen ID. Trim top hinge and place in holder in numerical order. Place holders in carrying case
INAA3
1. Cu ID
2. Specimen ID
Signed & dated
6S
To reactor
Key
Data Flow
Task Flow
Task
Data Sheet
Paper Tape

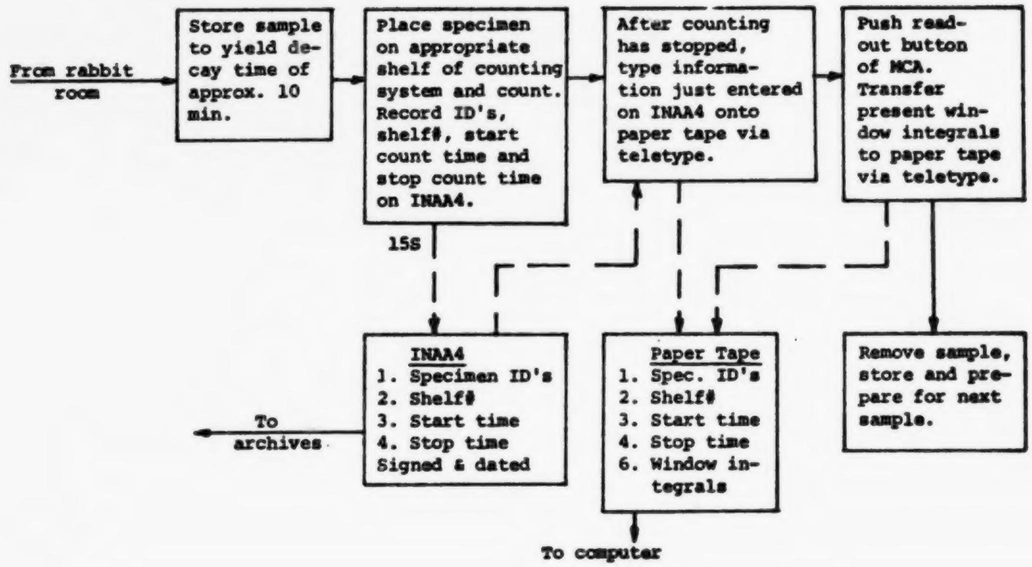
Figure 55. Specimen Loading


Sign in for experiment at console
From Lab
Load 2 dram specimen/ monitor vial top side up into rabbit.
7S
Irradiate for 5 min. Label clean 2 dram vial with Cu ID. Label another 2 dram vial with specimen ID. Record time at which rabbit leaves reactor.
8S
Remove 2 dram vial from rabbit. Open it and remove inner vials.
9S & 10S
From Lab
INAA3
1. Reactor out time Signed & dated
To counting room for Cu counting next day.
Open 2/5 dram specimen vial & transfer specimen envelope to clean, pre-labeled 2/5 dram vial. Place this into labeled 2 dram vial.
Cu Monitor
12S, 13S, 14S to counting room
Store Cu Monitor for one day.
11S
To counting room next day

* Clean implies leached overnight in 3 molar HNO_3 and rinsed with deionized water.

Figure 56. Reactor Room

a. Specimen Counting


From rabbit room
Store sample to yield decay time of approx. 10 min.
Place specimen on appropriate shelf of counting system and count. Record ID's, shelf#, start count time and stop count time on INAA4.
After counting has stopped, type information just entered on INAA4 onto paper tape via teletype.
Push read-out button of MCA. Transfer present window integrals to paper tape via teletype.
15S
INAA4
1. Specimen ID's
2. Shelf#
3. Start time
4. Stop time
Signed & dated
To archives
Paper Tape
1. Spec. ID's
2. Shelf#
3. Start time
4. Stop time
6. Window integrals
To computer
Remove sample, store and prepare for next sample.

b. Cu Foil Counting

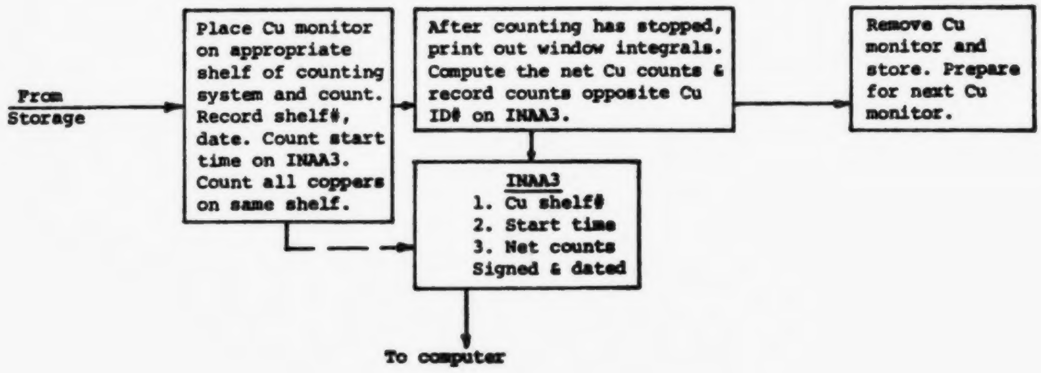

From Storage
Place Cu monitor on appropriate shelf of counting system and count. Record shelf#, date. Count start time on INAA3. Count all coppers on same shelf.
After counting has stopped, print out window integrals. Compute the net Cu counts & record counts opposite Cu ID# on INAA3.
Remove Cu monitor and store. Prepare for next Cu monitor.
INAA3
1. Cu shelf#
2. Start time
3. Net counts
Signed & dated
To computer

Figure 57. Counting Room

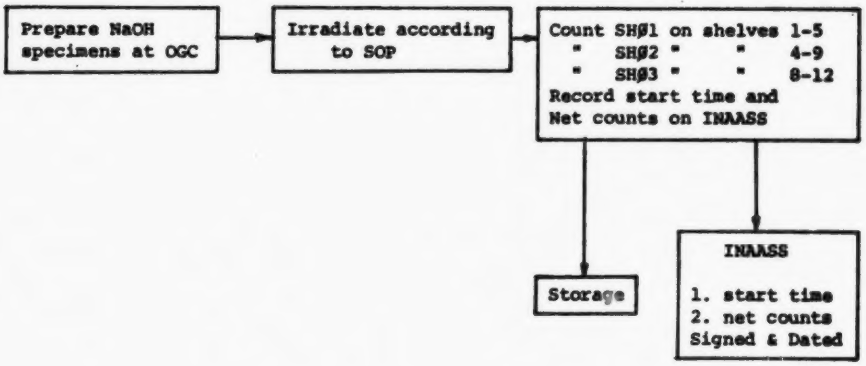

Prepare NaOH specimens at OGC
Irradiate according to SOP
Count SH01 on shelves 1-5
" SH02 " " 4-9
" SH03 " " 8-12
Record start time and
Net counts on INAASS
Storage
INAASS
1. start time
2. net counts
Signed & Dated

Figure 58. Shelf Factor Counting

$$(2)\quad N_i = GA_i(e^{-\ it^1} - e^{-\ it^2})\left(\frac{t_L}{t_2 - t_1}\right)$$

where G is a proportionality constant determined by the detector efficiency and detector-sample geometry and t_L is the present "live time" counting period.

Standards which contain fraction f_i of element i and of measured total mass m_s were irradiated for an equal time, and counted between times t_1^s and t_2^s after irradiation.

Analogous to eq. (2), the net number of counts measured is:

$$(3)\quad N_i^s = G\ k_i\phi^s f_i m_s\ (1 - e^{\lambda_i t})(e^{\lambda_i t_1^s} - {}^{\lambda_i t_1^s})\left(\frac{t_L^s}{t_2^s - t_1^s}\right)$$

where the s superscipt indicates quantities unique to the standard. Dividing eq. (1) by eq. (3) and cancelling like quantities yields:

$$(4)\quad \frac{N_i}{N_i^s} = \frac{\phi}{0^s}\ \frac{m_i}{f_i m_s}\ \frac{(e^{-\lambda_i t_1} - e^{-\lambda_i t_2})}{(e^{-\lambda_i t_2^s} - -\lambda_i t_2^s)}\ \frac{\left(\frac{t_L}{(t_2 - t_1)}\right)}{\left(\frac{t_L^s}{(t_2^s - t_1^s)}\right)}$$

The flux ratio, $\frac{\phi}{\phi s}$, is determined from the copper foil flux monitors of known mass. This ratio is:

$$(5)\quad \frac{\phi}{\phi s} = \frac{N_c}{N_c^s}\ \frac{m_c^s}{m_c}\ \frac{e^{-\lambda_c t_{c1}^s}}{e^{-\lambda_c t_{c1}}}$$

where the subscript c refers to quantities associated with the flux monitors; eq. (4) is solved for m_i and incorporating eq. (5)

$$(6) \quad m_i = f_i m_s \frac{N_i}{N_i^s} \frac{N_c^s}{N_c} \frac{m_c}{m_c^s} \frac{e^{-\lambda_c t_{c1}}}{e^{-\lambda_c t_{c1}}} \frac{\left(\dfrac{t_L^s}{(t_2^s - t_1^s)}\right)}{\left(\dfrac{t_L}{t_2 - t_1}\right)} \frac{(e^{-\lambda_i t_2^s} - {-\lambda_i t_2^s})}{(e^{-\lambda_i t_2^s} - {-\lambda_i t_2^s})}$$

Eq. (6) was used to determine the mass of element i from the observed parameters.

The relative standard deviation was determined by adding significant contributions in quadrature.

$$(7) \left[\frac{\sigma_{m_i}}{m_i} = \frac{\sigma^2_{m_c}}{m_c^2} + \frac{\sigma^{2s}_{m_c}}{m_c^{s2}} + \frac{\sigma^2_{m_s}}{ms^2} + \frac{\sigma^{2s}_{N_i}}{Ni^2} + \frac{\sigma^2_{N_i}}{N_i^{s2}} + \frac{\sigma^{2s}_{N_c}}{N_c^2} + \frac{\sigma^{2s}_{N_c}}{N_c^{s2}}\right]^{1/2}$$

The relative contribution to the uncertainty of the exponential terms is insignificant for the elements under consideration.

6. AQUATIC PROCEDURES

6.1 Pre-treatment and Cleaning Procedures for Sample Bottles

Sample bottles for trace metal analysis were new Nalgene 250 ml conventional polyethylene (low density) bottles with polyethylene caps, and Wheaton borosilicate glass bottles.

The polyethylene bottles were precleaned by a "Liquinox" detergent wash followed by rinsing several times with ASTM type I high-purity water. The bottles were then soaked in hot (70 C) 8 N analytical reagent grade HNO_3 for 72 hours, then rinsed with copious amounts of high-purity water and oven-dried at 70 C. After each sampling period, the bottles were detergent washed, rinsed with high-purity water, washed with 5 N HNO_3, rinsed with high-purity water, and dried. The borosilicate bottles received the same precleaning and post sampling cleaning as the polyethylene bottles except the HNO_3 was concentrated. After drying, the bottles were stored in containers free from contamination until use.

6.2 Sampling

All samples were collected from just below the surface film. The bottles were rinsed twice with the receiving water before the sample was taken. Samples for Cd, Cr, Cu, Zn, Pb, Ni, Mo, and Se were collected in 250-ml polyethylene bottles. Samples for As and Hg were collected in 500-ml borosilicate bottles.

The Hg bottles contained sufficient HNO_3 and $K_2Cr_2O_7$ present in the container before the water was introduced to make the final sample 5% (v/v) and 0.05% (by wt.), respectively. The samples were transported to the laboratory in an ice-filled chest and with the exception of Hg, were immediately filtered through a 0.45-μ Millipore filter and acidified to a pH of <2 with Baker's "Ultrex" HNO_3.

6.3 Analytical Procedures

1) Surface temperature was taken with an A.S.T.M. thermometer and bottom temperature was determined by using a Yellow-springs themistor.

2) pH was determined at each site with a Markson Model LJ-85 portable pH meter. Standard buffer solutions that covered the range of pH of the samples were used to standardize the instrument at each site.

3) Specific conductance was determined in the laboratory by using a wheatstone bridge with values expressed in microohms per centimeter at 25 C.

4) Dissolved oxygen was determined using the following modified Winkler Method.

Field:

a) Fill B.O.D. bottle from just below the surface film, flushing the bottle while avoiding the introduction of bubbles.

b) Stopper bottle carefully, check for bubbles by inverting bottle.

c) Add 2-ml manganous sulfate by letting the fluid run down the neck of B.O.D. bottle.

d) Add 2-ml alkaline iodide solution.

e) Stopper and give "Winkler shake." If there are any bubbles present in bottle, discard sample and begin again.

f) If there are no bubbles in bottle, allow precipitate to settle; repeat the mixing after precipitate settles to 1/2 - 1/3 bottle volume.

g) After precipitate has settled to 1/3 volume of bottle volume, add 2-ml concentrated sulfuric acid. Repeat "Winkler shake" twice, with 5 to 10 minutes between shakes.

Note: Bubbles introduced after this step will not effect the results of the oxygen determinations.

Laboratory:

a) Pour sample into 203-ml flask to overflowing, wipe off excess on outside of flask, pour contents into 250-ml flask. Rinse 203-ml flask once with dH$_2$ into 250-ml flask.

b) Titrate with 0.025 N sodium thiosulfate ($Na_2S_2O_3$) using magnetic stirrer until you near end point which is a pale yellow color.

c) Add about 1 ml of starch indicator; the sample should turn a pale blue. If no color develops, start over at step (a).

d) Continue titration very slowly (1-2 drops at most) to a colorless end point. Usually it takes 1/2 to 1 drop to make the solution colorless.

The amount of $Na_2S_2O_3$ (ml) determines the correction factor. If titrant was too strong, less than 10 ml were needed to reach the end point, and if titrant was too weak, more than 10 ml were needed.

e.g.; ml titrant = 9.9

c.f. = 10 ÷ 9.9

= 1.01

and if

ml titrant = 10.2

c.f. = 10 ÷ 10.2

= 0.98

To calculate mg O_2/l:

ml titrant x c.f. = mg O_2/l

5) Alkalinity was determined using the following procedure.

Apparatus:

a) Electrometric titrator: Beckman, Model HG, glass electrode pH meter. Read pH to 0.05 pH unit. Make titrations at 25±2 C.

b) Titration vessel: 55-ml plastic disposable beakers.

c) Magnetic stirrer.

d) Pipets: 24 ml volumetric.

e) Buret: 50 ml volumetric graduated to 0.1 ml.

Reagents:

a) Standard sulfuric acid (0.1 N): Dilute 3.0 ml concendrated H_2SO_4 to one l with distilled water. Standardize against 40-ml 0.05 N Na_2CO_3 solution, with about 60 ml water, in a beaker by titrating potentiometrically to pH of about 5. Lift out electrodes, rinse into the same beaker, and boil gently for 3 - 5 min. under a watch glass cover. Cool to room temperature, rinse the cover glass into the beaker, and finish the titration to pH 4.5. Calculate the normality according to:

$$\text{Normality, N} = \frac{A \times B}{53.00 \times C}$$

Where A = g Na_2CO_3 weighed into one l, B = ml Na_2CO_3 solution used in titration, and C = ml acid used.

Use measured normality in calculations or adjust to exactly 0.100 N. A 0.100 N solution = 5.00 mg $CaCO_3$/ml.

b) Sodium carbonate solution (approximately 0.05 N): Dry 3 to 5 g primary standard at 25 C for 4 hr and

and cool in a desiccator. Weigh 2.5±0.2 g (to the nearest mg), transfer to a one l volumetric flask, and fill to the mark with distilled water.

c) Standard sulfuric acid (0.02 N): Dilute 100 ml 0.100 N standard acid to one l with distilled water. Standardize by potentiometric titration of 15.00-ml 0.05 N Na_2CO_3 using the procedure outlined in step 1.

0.200 N solution = 1.00 mg $CaCO_3$/ml.

Procedure:

a) Calibrate pH meter.

b) Pipet 25 ml of sample into 55-ml plastic disposable beaker, add magnet, place on magnetic stirrer.

c) Insert Ph probe, stir, read pH after 1 min. Wait 10 sec.; if pH hasn't changed record.

d) If pH is above 8.3, titrate with 0.02 N H_2SO_4 to a pH of 8.3. Record ml. Calculate CO_3 in $CaCO_3$/ml, multiply ml of acid by 48.

e) Continue to titrate to pH 4.5 Calculate alkalinity, multiply total ml by 40.

f) Calculate HCO_3, when initial pH is less than 8.3; multiply alakalinity by 1.22.

g) Calculate HCO_3, when initial pH is greater than 8.3; double the ml of acid to 8.3, subtract this from the total ml and multiply this difference by 48.84 (40 x 1.22).

(Total Vol)-(Vol of acid to pH 8.3)(2)   (40)(1.22)

The atomic absorption analyses were performed by the Chemistry Department at North Dakota State University.

6) Flameless atomic absorption spectrometry was employed for the determination of the following trace elements: As, Cu, Cd, Cr, Pb, Mo, N, Se, and Zn. A Perkin-Elmer Model 603 AA with Background Corrector Assembly is used in conjunction with a Perkin-Elmer Model HGA-2100 graphite furnace. The furnace can be preprogrammed for sample drying, charring and atomization at selected temperatures for selected periods of time for each element. Absorbance can be read directly on the AA.

Direct sample injection (50 l) into the graphite furnace was performed for each element. A calibration curve was used to determine the unknown concentration. This procedure seems to work quite efficiently for most of the elements for routine analysis. However, some indirect method with much higher sensitivity (such as hydride generation method for As and Se) is available but is not routinely used since the method is time-consuming. For Hg, however, the cold-vapor method was used. Standard solutions were checked daily against EPA reference samples for accuracy. The procedures used for each element are shown in Table 70.

7) Mercury determination by the atomic absorption cool vapor method follows:

Sample Preparation:

a) Draw 50-ml aliquot of sample and place it in a large test tube (2.5 x 20 cm)

b) Add digesting agents to the sample.

    a) 2 ml of 5% w/v Potassium Persulfate ($K_2S_2O_8$) Reagent Grade.

    b) 2 ml of 5% w/v Potassium Permanganate ($KMnO_4$) Reagent Grade.

    c) 3 ml of Concentrated Sulfuric Acid

    d) 1 ml of Concentrated Nitric Acid

TABLE 70

PROCEDURES FOR ANALYSIS OF TRACE ELEMENTS IN WATER

Element	Technique	Procedure	Sensitivity (50 µl Sample Projection)
As	Flameless AAS PE 603/HGA 2100; Background corrector on; 193.7 nm line; EDL; Gas-flow interrupt mode Argon as purging gas, Temp. program: Dry = 125°C (30 sec); Char = 350°C (20 sec.); Atom = 2300°C (8 sec).	Standard solution of As (500 ppm) was prepared by dissolving As_2O_3 in 0.1 M NaOH solution. Other solutions were prepared by dilution.	1 ppb (5 x10^{-11} g). Detection Limit = 1 ppb.
Cu	Flameless AAS PE 603/HGA 2100 Hollow Cathode Lamp 325 nm line Argon as purging gas flow rate = 20 divs. on HGA 2100. Temp Program: Dry = 125°C (30 sec); Char = 1000°C (20 sec.); Atom = 2500°C (8 sec.).	Standard solution of Cu (1000 ppm) was prepared by dissolving CuO in 10 ml 6M HNO_3 with boiling and mode up to 1000 ml. Other solutions were prepared by dilution. Sample (50 µl or less) injected directly into the furnace.	1 ppb (5 x 10^{-11} g). Detection Limit = 1 ppb.
Cd	Flameless AAS PE 603/HGA-2100 Hollow Cathode Lamp; 283 nm line Argon as purging gas, flow rate = 20 divs. Temp. program: Dry = 125°C (30 sec); Char = 400°C (20 sec.); Atom = 1500°C	Standard solution of Cd (1000 ppm) was prepared by dissolving $CdCl_2$ in water, acidified with 10 ml 6M HNO_3, and mode up to the volume (1000 ml). Other solutions were prepared by dilution. Sample (50 µl or less) injected directly into the furnace.	0.04 ppb (2 x 10^{-12} g) Detection limit = 0.04 ppb.
Cr	Flameless AAS PE 603/HGA 2100 hollow cathode lamp; 357.9 nm line; argon purging gas; gas flow rate = 20 divs. Temp. Program = Dry = 125°C (30 sec.); Char = 1350°C (209 sec.); Atom = 2700°C (8 sec.).	Standard solution of Cr (1000 ppm) was prepared by dissolving K_2CrO_4 in water. Other solutions were prepared by dilution. Sample (50 µl or less) injected directly into the furnace.	0.4 ppb (2 x $^{-11}$ g). Detection limit = 0.5 ppb.
Hg	Cold vapor method PE 303/PE 165 Recorder hollow cathode lamp; 253.7 nm line.	Standard solution of Hg (1000 ppm) was prepared by dissolving HgO in a minimum volume of (1:1) HCl and mode up to the volume (1 liter). Other solutions were prepared by dilution. Procedure attached later.	Absolute Sensitivity = 5 ng; Detection limit = 0.1 ppb
Mo	Flameless AAS PE 603/HGA 2100; Pyroically coated graphite tubes. Hollow Cathode Lamp 313.3 nm line; Argon as purging gas, flow rate = 20 divs. Temp. program: Dry = 125°C (30 sec.); Char = 1800°C (20 sec.); Atom = 2700°C (8 sec.).	Standard solution of Mo (1000 ppm) was prepared dissolving ammonium paramolybdate $(NH_4)_6Mo_7O_{24}$, $4H_2O$ in 1% (V/V) NH_4OH. Other solutions were prepared by dilution. Sample (50 µl or less) is injected directly into the furnace.	0.8 ppb (4 x 10^{-11} g); Detection limit = 1.4 ppb.

TABLE 70 (continued)

Element	Technique	Procedure	Sensitivity (50 µl Sample Projection)
Ni	Flameless AAS PE 603/HGA 2100 hollow cathode lamp 232.0 nm line; Argon as purging gas, flow rate = 20 divs. Temp. program: Dry = 125°C (30 sec.); Char = 1200°C (20 sec); Atom = 2500°C (8 sec.).	Standard solution of Ni (1000 ppm) was prepared dissolving $Ni(NO_3)_2$ in 1% (V/V) HNO_3. Other solutions were prepared by dilution. Sample (50 µl or less) is injected directly into the furnace.	2 ppb (1×10^{-10} g); Detection limit = 4 ppb.
Pb	Flameless AAS PE 603/HGA 2100 Hollow Cathode Lamp 283.3 nm line Argon as purging gas; flow rate = 20 divs. Temp. program: Dry = 125°C (30 sec.); Char = 550°C (20 sec.); Atom = 2000°C (8 sec.)	Standard solution of Pb (1000 ppm) was prepared by dissolving $Pb(NO_3)_2$ in 1% (V/V) HNO_3. Other solutins were prepared by dilution. Sample (50 µl or less) is injected directly into the furnace.	0.9 ppb (5×10^{-11} g) Detection limit = 1 ppb
Se	Flameless AAS PE 603/HGA 2100; Electrodeless discharge lamp 196 line; Background corrector; argon as purging gas but gas-flow interrupt mode used. Temp. Program: Dry = 125°C (30 sec.); Char = 350°C (20 sec.); Atom = 2200°C (8 sec.).	Standard solution of Se (1000 ppm) was prepared by dissolving pure selenium in conc. HNO_3, evaporated to dryness, added water and again evaporated to dryness 2-3 more times and then made up to the volume by 10% (V/V) HCl. Other solutions were prepared by dilution. Sample (50 µl or less) is injected directly into the furnace.	2 ppb (1×10^{-10} g) Detection limit = 2 ppb.
Zn	Flameless AAS PE 603/HGA 2100 hollow cathode lamp; 213.9 nm line; argon as purging gas, flow rate = 80 divs. Temp. Program: Dry = 125°C (30 sec.) Char = 500°C (20 sec.); Atom = 2000°C (8 sec.).	Standard solution of Zn (1000 ppm) was prepared by dissolving pure Zn metal in a minimum volume of (1:1) HCl and then made up the volume with 1% (V/V) HCl. Other solutions were prepared by dilution. Sample (50 µl or less) is injected directly into the furnace.	0.1 ppb (5×10^{-12} g) Detection limit = 0.2 ppb.

c) Cover test tubes with aluminum foil, place in rack, and heat at 90-95 C for 2 hr; remove from boiler and allow to cool to room temperature.

Instrument Settings and Adjustments:

a) Perkin-Elmer Model 303

    a) all settings as indicated in standard conditions.

b) 165 (recorder): noise suppression = 2; scale expansion = X10

Cool Vapor Apparatus Adjustments:

a) Optical path base must be seated over the notch in the flame head mount.

b) Drierite must be replaced each day.

c) Pressure control valve on the nitrogen cylinder should be set at slightly under 10 psi (check daily because it changes).

d) Vari AC control should be at 19.

Procedure:

a) Immediately before putting sample into stripping flask add 1.5 ml of 10% sodium chloride, 10% hydroxylamine sulfate to the sample and stir until all color is gone.

b) Pour sample into stripping flask - rinse test tube and stirring rod into flask.

c) Mount stripping flask on the bubbler and adjust the bubbling rate using the teflon stopcock. (Low Rate 150-200 bubbler per min.)

d) Inject 10 ml of $SnSO_4$ suspension shake well. Make up by diluting 20 g of Reagent Grade $SnSO_4$ and 7 ml of concentrated sulfuric acid to 500 ml with deionized water.

e) After stripping for 20 min., transfer the gas delivery tube from the bubbler to the trap and allow the gas to flow without heating for 0.5 min.

f) Turn Vari AC switch to On. The Hg signal should appear in 0.8 to 0.9 min.

7. PRECIPITATION SAMPLING

7.1 Collection Device

An Aerochem Metrics Model 201 Automatic Sensing Wet/Dry Precipitation Collector was operated from May through September of 1978.

This unit was installed at the ambient aerosol sampling site A2, about 4 meters above the ground. This unit is designed to operate on 12 volt D.C. current or 110 volt A.C. current.

In order to melt snow or ice, which will then trigger a cycle, the rain sensor has a thermistor circuit set to turn on the heater if the temperature drops below 4 C. The thermistor circuit also limits the maximum temperature of the plate to 50 C. To speed precipitation evaporation, the heater circuit is energized during the "wet" collection period; it is thermistor-limited at 50-60 C. The heater circuit is a semi-proportionating type. The temperature settings are adjustable by means of potentiometers located on the precipitation sensor head.

7.2 Collection Procedures

When the unit is connected to its power source, the roof containing a polyethylene foam pad on its underside will move to cover the "wet" polyethylene bucket which is located at the end away from the rain sensor. When precipitation occurs the roof will move to cover the "dry" bucket and thus expose the "wet" bucket.

The collection bucket and containment bottles were of the same type, and received the same pretreatment and cleaning procedures as did the water sampling bottles.

7.3 Analysis

The same trace metals were analyzed as are found in the aquatic section.

8. SNOW PROCEDURES

8.1 General Discussion

Snow samples were collected on Wednesday, January 24, 1979, for certain chemical analyses of the snow melt. The criteria upon which sites were selected for obtaining the snow samples are described below. Two primary factors were considered: the distances from the facility and direction from the facility.

8.2 Surface Samples

Distance:

An atmospheric transport and deposition model was used to determine the downwind distance at which ambient air concentrations at ground surface of trace elements would be maximum. This distance is dependent upon wind speed, mixing height (top of planetary boundary layer), and stability (Pasquill Stability Class).

The model was not executed using specific meteorological conditions in which the snow might have scavenged certain trace elements. This information was not immediately available for the period of several weeks prior to the decision to collect the snow.

Execution of the computer model using average annual meteorological conditions indicates that the maximum ambient air concentration, at the ground surface, of drace elements should be located from 6.5 to 10 kilometers downstream of the facility. Stability Classes C and D (slightly unstable and stable, respectively) are prominent during the year.

Direction:

Surface and 850-mb facsimile charts were obtained from the local office of the National Weather Service (NWS). These charts indicate fresh snow was occurring, in the area of the facility, between the hours of 1 a.m., Monday, January 22, and 7 a.m., Tuesday, January 23. Most of the snow flurry activity occurred from 1 a.m. to 10 p.m., Monday, January 22. Surface temperatures during this time at the Bismarck office of the NWS decreased from -9 C to -16 C.

A surface low pressure system moved east-southeast across South Dakota and Nebraska placing the study area on the north side of the low. Surface wind directions persisted during the day of Monday from a northerly direction, shifting from a north-northeast to the northwest. Wind speeds were typically reported at 5 m/sec but were 10 m/sec for three hours during the afternoon of Monday.

During field sample collection the following Wednesday, observation indicated that a fresh snow cover of about 2.5 cm blanketed the area. The appearance of this blanket of fresh snow gave the impression that the snow did not drift significantly during the snowfall.

8.3 Depth Samples

Temperatures during the early afternoon hours on Wednesday, Thursday, Friday, Saturday, and Sunday (January 17 to 21) were above -7 C. The 4 p.m. temperatures at Bismarck were -4 C, -3 C, missing, -4 C, and -4 C, respectively for these days. The 1 p.m. temperature at Bismarck on Wednesday was -6 C. Wind directions on Friday and Saturday afternoons were from the northwest. Wind directions during afternoons of the other days were variable, but generally from the southeast quadrant.

8.4 Site Selection

It is logically desirable to collect the snow samples at locations and under conditions for which the likelihood is maximum for detection of the trace elements. Further, it is desirable to obtain a measure of spacial variability of snow trace element concentrations, given that hypothesis of snow scavenging are correct.

Sites for collection of fresh surface samples were selected along a 6.5-km radius downwind of the facility from the east-southeast through south-southwest directions. In addition, sites were selected along one radial from the facility at distances between 1 and 10 km. A map of these site locations is shown in an attached figure.

Two sites were selected for collection of sub-snow surface snow samples. These sites were chosen downwind of the facility under the meteorology of Friday and Saturday afternoons, January 19 and 20, respectively.

8.5 Sample Collection Procedure

Collection of the 19 samples began at 9:15 a.m. on January 24, 1979 and was completed by 3:15 p.m., the temperature did not exceed -13 C. With the exception of number 17_s and E_s the samples are surface samples consisting of the top 1 cm of snow. Samples were taken with a stainless steel spatula from an area about 2 m^2. The samples were placed in Nalgene zip-lock polyethylene bags.

9. VEGETATION SOILS AND SEDIMENT PROCEDURES

9.1 Vegetation Sampling

Every attempt was made not to sample plants that were heavily covered with soil or dust, damaged by insects, mechanically injured, or diseased. Many species of vegetation found in North Dakota are subject to attack by a number of pathogenetic organisms. Dead plant tissue was not included in the sample. Samples were cut with stainless steel shears, most samples were cut at least 5 cm above the ground to avoid contamination.

9.1.1 Handling of Sample After Collection

Field samples were placed in clean Nalgene zip-lock polyethylene bags, placed in covered polyethylene pans and placed in an ice-filled chest pending arrival at the laboratory. The samples were stored at 2 C pending the cleaning operation and oven drying. All samples were prepared for drying the same day of collection.

9.1.2 Cleaning of Plant Material

The cleaning procedure consists of eight steps and did not exceed 60 sec contact time with the water.

- tap water rinse

- wash in a 0.1% 'Joy' detergent solution
- rinse with running tap water
- a series of four distilled water rinses
- blot dry with clean towels

The cleaned samples were placed in Kraft paper bags and transferred immediately to a forced-draft oven for drying.

9.1.3 Drying

The plant material was placed in a forced-draft electrical oven at 50 C for 12 to 24 hr. After removal and cooling, the samples were ground, placed in screw-cap bottles that were thoroughly cleaned, and dried again for 12 hr at 50 C. The bottles were immediately stoppered after removal from the oven and while still warm.

9.1.4. Grinding

Samples were ground to pass a 40-mesh sieve using an all stainless steel Wiley Mill (Model ED-5). Along with the routine cleaning procedure, the mill was "preconditioned" before each use by grinding Kimwipes or several vegetative samples that were to be discarded.

9.1.5 Storage

After grinding, the samples were thoroughly mixed and placed in screw-cap bottles following the drying procedure as stated above.

9.2 Soil Sampling

Sixty-four plots were chosen for soil and vegetative sampling. Samples were taken from each end of the plot approximately 30 m apart. All sites had a 0 - 10-cm core taken with a tooled-steel coring device. Twenty of the 64 plots had an additional 0 to 1.3-cm sample taken with a stainless steel spatula. Each sample was a composite of two subsamples collected 30 m apart. Twenty-eight plots had a 91-cm core taken with a hydraulic coring machine mounted on a pickup truck. The samples were placed in clean Nalgene zip-lock polyethylene bags for transport to the laboratory where they were placed on polyethylene sheets, air-dried, crushed with a wood mallet, and sieved through a 2-mm polyethylene screen. Precautions were taken to avoid contamination during sampling, drying, crushing, and storage.

9.3 Sediment Sampling

Sediment samples were taken at all sites with a Wildco K. B. core sampler with plastic tube liners. New liners were used and underwent the same precleaning procedure as the polyethylene bottles. The samples were frozen immediately in dry ice and transported to the laboratory where they were kept in a frozen state until analyzed. At the time of analysis, the top 4 cm of each core was sectioned, air-dried, and analyzed.

9.4 Analytical Procedures

The analysis were performed by the Soils Testing Laboratory at Colorado State University.

9.4.1 Total Digestion Procedures

Plants (All Elements):

Weigh 1 g of plant material into a 50 ml volumetric flask. Add 10 ml of 4:1 HNO_3-$HClO_4$ acid and predigest with no heat for several hours. Place on a hot plate, heat gently (~100 C) until the dense brown-red fumes have disappeared. Increase heat carefully (~200 C) and continue digestion until a colorless solution containing a white silica precipitate remains. Reduce heat and cool to 90 C, add 20 ml of H_2O and heat gently for 30 min. Remove from the hot plate, allow the solution to cool and bring to volume.

Soils and Sediments (All Elements Except S):

Weigh 1 g of soil into a 100 ml teflon beaker. Add 20 ml of 1:1 HNO_3-$HClO_4$ acid, cover with a teflon watchglass and heat overnight at ~200 C. Remove the watchglass and continue heating until the volume is reduced to 2 to 3 ml. Cool the sample, add 15 ml of 2:1 HF-$HClO_4$ acid. Cover with the teflon watchglass and heat overnight at ~200 C. Remove the watchglass and continue heating until the volume is reduced to 2 to 3 ml. Cool, add 10 ml of 50% HC, cover and heat at ~100 C for 30 min. Remove from the hot plate, allow to cool, transfer the solution to a 50 ml volumetric and bring to volume (2).

Soils and Sediments (Organic S and Soluble Inorganic SO_4):

Weigh 2.5 g of soil into an 18 ml high form crucible. Mix 0.5 g of $NaHCO_3$ with the soil, and add another 0.5 g evenly to the surface of the sample. Heat the sample at 500 C for 3 hr in a muffle furnace. Cool and transfer the sample to 50 ml Erlenmeyer flask. Add 25 ml of extracting solution. Use the solution first to rinse the crucible. Shake for 30 min and filter the suspension. Use the $BaSO_4$ turbidimetric method to determine SO_4 in the extract (3).

9.4.2 Extraction Procedures - Soils - Sediments

Cu, As, Ni, Cd, Cr, Pb

Extracting solution : 0.005 $\underline{M}$ DTPA, 0.01 $\underline{M}$ $CaCl_2$, 0.1 $\underline{M}$ TEA.

Procedure: Weigh 10 g of soil into 125 ml Erlenmeyer flasks. Add 20 ml of extracting solution and shake for 2 hr. Filter and determine element concentrations using ICAP (4).

Se:

Extracting solution: H_2

Procedure: Weigh 10 g of soil into 150 ml beakers. Weigh the beakers containing the soil. Add 50 ml of H_2), cover with a watchglass and heat for 4 hr on a steam bath. Allow the water-soil suspension to cool and settle overnight. Weigh the beakers containing soil and water to determine the water remaining and to calculate the dilution factors. Filter and determine the Se concentrations using atomic absorption with hydride generation (5).

S:

Extracting solution: 0.5 M ammonium acetate, 0.25 N acetic acid

Procedure: Weigh 10 g of soil into 125 ml Erlenmeyer flasks. Add 25 ml of extracting solution and shake for 30 minutes. Filter and determine the SO_4 in solution using the $BaSO_4$ turbidimetric method (3).

Mo:

Extracting solution: 1 M ammonium carbonate, pH 9.0

Procedure: Weigh 10 g of soil into 125 ml Erlenmeyer flasks. Add 20 ml of extracting solution and shake for 12 hours. Filter and determine Mo concentrations using the ICAP (6).

9.4.3 ICAP Operating Parameters and Procedures

Instrumentation

The performance characteristics of the Jarrell-Ash Model 975 Atom Comp are shown below.

Incident Power	1.25 KW
Reflected Power	<3 W
Nebulizer type	Cross flow-tungsten carbide tubing, sharpened, 0.99 mm O.D., 0.25 mm I.D.
Nebulizer Pressure	80 psi
Argon Flow rates	
Coolant	16 l/min.
Sample	0.5 l/min.
Sample aspiration rate	0.7 ml/min.
Observation height	16 mm above work coil.

Element	Analytical line Å	Detection Limit µg/l*
Cu	3247	1.0
Zn	2062 (2nd order)	1.5
Ni	2316 (2nd order)	3.0
Mo	2020	2.0
Cd	2144	1.5
Cr	2677	1.5
Pb	2203	30

* Concentration giving signal equal to twice the standard deviation of the background signal. Determined in a H_2O solution containing no interelement interferences.

Standards:

Standards are prepared in solutions containing similar acid or salt concentrations as the samples. Two solutions are generally used to standardize an element; the blank and a standard containing a concentration of analyte of the same magnitude as the unknowns. The following standard solutions were used:

Plant Digests:

a) Blank
b) 400 ppm Ca, K; 100 ppm Mg; 50 ppm P; 10 ppm Na, Al, Fe
c) 1 ppm Cd, Cu, Pb, Ni, Zn, Mo
d) 1 ppm Cr

Total Soil Digests:

a) Blank
b) 4 ppm Cd, Cu, Pb, Ni, Zn, Mo
c) 200 ppm Ca, Mg, Na, K; 20 ppm P; 4 ppm Cr
d) 400 ppm Fe, Al; 40 ppm Ti; 20 ppm Mn

DTPA Extracts or 1 M $(NH_4)_2CO_3$ Extracts:

a) Blank
b) 10 ppm Ca, Mg, Na, K, P, Al, Fe, Mn
c) 1 ppm Cu, Zn, Ni, Mo, Cd, Cr
d) 1 ppm Pb

After each solution reading was made, the nebulizer was rinsed with ~10 ml of H_2O. This decreased memory effects and prevented the buildup of salts on the nebulizer capillary tips. The 1 M $(NH_4)_2CO_3$ extract for Mo crystallized quickly on the nebulizer capillaries causing clogging. The problem was solved by treating 2 ml-aliquots of sample or standard solutions with 0.25 ml of concentrated HNO_3. This removed the carbonate from solution, leaving a more soluble solution of NH_4NO_3.

Interelement Interferences:

Certain elements cause spectral interferences with other elements. The interfering elements are usually found in much greater concentrations than the affected elements. One thousand μg/ml interfering element solutions were aspirated producing the apparent μg/ml concentrations of analyte. The following table shows the spectral interferences found to be important in this study.

Analyte*	Interfering elements (1000 mg/ml) Mg	 Al	 Fe
Cu	.01	0.01	.05
Zn	.08	.14	.06
Ni	.10	.01	.24
Mo	.04	.44	.12
Cd	.008	.13	.09
Cr	.05	.02	.23
Pb	.17	1.6	.38

* Affected elements (apparent concentrations in μg/ml)

The only solutions with large interelement interferences were the total soil digests. These solutions contained about 1000-μg/ml Al and 500-μg/ml Fe. This created a large background signal for Mo, Cd, and Pb. Because of the high background, the detection limits for these elements were severely degraded. The smallest detectable signal for these elements was considered to be a reading 10% greater than the background. The following table shows detection limits for Mo, Cd, and Pb.

	Apparent concentrations from background (100 μg/ml Al and 500 μg/ml Fe)		Smallest detectable concentrations 10% of background
Analyte	Solution (μg/ml)	Soil (μg/ml)	Soil (μg/ml)
Mo	0.50	25	2.5
Cd	0.18	9	0.9
Pb	1.79	90	9.0

Interelement corrections were made using the apparent concentrations arising from pure interfering element solutions and the concentrations of interfering elements found in the sample. If an affecting element concentration was high enough to produce a signal greater than 2% of the total affected element signal, a background correction was made.

9.4.4 Se Atomic Absorption Parameters

Apparatus:

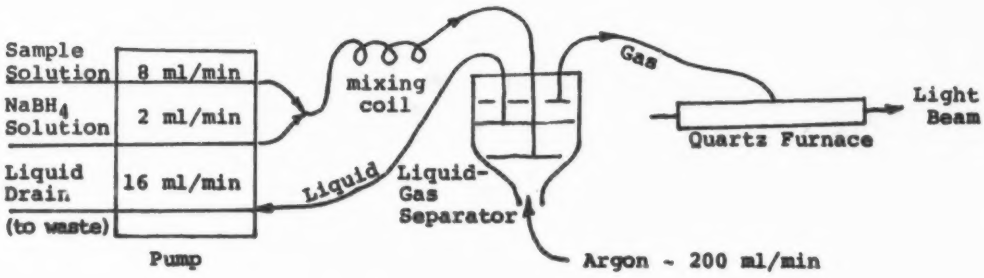
1) Perkin-Elmer Model 303 Atomic Absorption Spectrophotometer equipped with a Jarrell-Ash selenium hollow cathode lamp and a Scientific Products chart recorder.

2) 1 cm x 10 cm quartz tube furnace with an inlet tube fused at the midpoint. The tube is wrapped with nichrome heating wire and insulated with asbestos tape. The temperature is controlled with a 0 to 140 V variable transformer.

3) Masterflex variable speed peristaltic pump equipped with 3 pump heads.

4) Liquid-gas separator constructed from a 60 ml coarse fritted disc Buchner funnel.

Diagram of System:


Sample Solution
8 ml/min
NaBH$_4$ Solution
2 ml/min
Liquid Drain
16 ml/min
(to waste)
Pump
mixing coil
Liquid
Liquid-Gas Separator
Gas
Quartz Furnace
Light Beam
Argon - 200 ml/min

Operating Settings:

Wavelength	1960 nm
Lamp current	11 mA
Flow rates	
Argon	~200 ml/min.
Sample	8 ml/min.
$NaBH_4$ solution	2 ml/min.
Drain	16 ml/min.
Furnace	Adjust transformer to give the furnace a dull red color.

Reagents:

1) Concentrated HCl

2) $NaBH_4$ solution: 7.5 $NaBH_4$, 1.0 g NaOH dissolved in 1 liter.

Standards:

Standards are made by diluting a 1000-ppm Se (SeO_2 dissolved in H_2O) stock solution. A 5-ppb Se solution gives a peak height 60-70% of full scale.

Procedure:

3-ml standard or sample solutions made 2 N in HCl are pumped into the system. Between samples, the sample tubing is placed in 2 N HCl. When the signal has returned to zero, another 3 ml of sample solution is introduced. Peak heights are used to calculate the Se concentrations.

9.4.5 Soil pH Determination of Saturated Paste

About 200 g of air-dried soil is used to prepare a saturated paste. The glass electrode is inserted in the paste and raised and lowered repeatedly until a representative pH reading is obtained.

REFERENCES

(1) Cahill, T.A., R.A. Eldred, J. Barone, and L. Ashbaugh. Ambient Aerosol Sampling with Stacked Filter Units. Report No. FHWA-RD-78-178, Air Quality Group, Crocker Nuclear Laboratory, University of California-Davis, Davis, California, 73 p., 1979.

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APPENDIX B

QUALITY CONTROL AND ASSURANCE PRACTICES

1. QUALITY CONTROL AND ASSURANCE PRACTICES

1.1 General Discussion

Despite all of the recent sophisticated, highly sensitive analytical techniques, and instrumentation which have become available to the trace element analyst, the accurate and precise measurement of trace elements in environmental samples is still a very difficult task. This difficulty can be best illustrated by studying the results of several interlaboratory round robin exercises in which identical aliquots of the sample were analyzed for a variety of trace elements. The lack of interlaboratory agreement on the concentrations of many elements often exceed a factor of 10.

The present state of the art for measuring trace elements in environmental samples leaves something to be desired. Nevertheless, researchers who very carefully evaluate their procedures and eliminate the inherent sources of error can achieve reasonably accurate and precise results.

What makes the trace element analysis of environmental samples such a difficult analytical task? There are several reasons. First, the concentrations of a number of trace elements are present in many natural systems near or below the ppb level, and this level is on the borderline of the detection sensitivities of many of the popular analytical techniques presently in use. Secondly, at these extremely low concentrations, contamination problems are often overwhelming; and thirdly, natural systems are so complex in their physiochemical and biological makeups that very subtle partitioning among biotic and abiotic fractions greatly complicates storage and analysis of these samples.

It has often been said that an analysis is only as good as the sample on which it is performed. Thiers (   ) recommends that "unless the complete history of any sample is known with certainty, the analyst is well advised not to spend his time analyzing it." It could also be said that an interpretation or decision can be no better than the analytical data on which it is based.

The parameters to be controlled in an effective environmental analysis study are:

- developing standard operating procedures,
- develop standardizations in sampling, storage, containment, and preparation prior to and including analysis,
- laboratory environment,
- reagents,
- standards,
- contamination (resulting in positive, negative, and pseudo forms),
- analyst, qualifications and attitude.

It must be recognized and practiced, that quality control begins with the sample collection and does not end until the resulting data are reported, and that validity is a very expensive commodity.

Since containment, pre-treatment, and cleaning procedures, as well as the sampling procedures are presented in Appendix A, only the analytical Q.A. will be presented in this section.

The following material is presented in three groups of three, based on the analytical procedures employed for each group.

1.2 Coal, In-Stack, and Ambient Aerosol Q.A.

The elemental quality assurance program for the coal, in-stack filter, and ambient aerosol filters was based on:

a) intermethod comparison,

b) interlaboratory comparisons,

c) certified NBS standards,

d) recycled specimens, and

e) recycled secondary standards.

Intermethod comparisons on 100% of the samples constitutes the primary Q.A. procedure. Each filter or coal sample selected for intensive chemical analysis was analyzed by instrumental neutron activation analysis (INAA) and X-ray fluoroescence (XRF). Each measured certain elements which was also measured by one or both of the procedures as shown in Table 71. Al, K, Ti, V, Mn, Br, Cl, and Ba were measured by both XRF and IVAA.

The second main Q.A. program is schematically outlined in Figure 51 and consists of intermethod and interlaboratory comparisons. Whole filters were sent to Battelle Northwest (BNW), University of California, Berkeley (UCB) and to the Research Triangle Park EPA laboratory for XRF analysis after they had been analyzed at OGC by XRF. They were then be returned to OGC where they were passed through the normal analysis process. This extensive interlaboratory and intermethod comparison was done on about 200 filters.

As a third type of check, whole intensive day filters were recycled through the XRF analysis while nonintensive day filters were cut into quarters and all four quarters cycled through the INAA at different intervals.

The fourth Q.A. audit consists of the analysis of blind NBS certified standards such as orchard leaf and USGS standards such as BCR-1 by INAA.

Because of timing, this data was not very effective as a control function but served as documentation of the accuracies achieved.

1.3 Water, Precipitation, and Snow Q.A.

The routine laboratory Q.A. consisted of running various secondary standards plus EPA reference samples with each batch of samples analyzed, and participating in interlaboratory calibration exercises on a quarterly basis. In addition to the laboratory Q.A., 5% of the elemental determinations made were Q.A. analysis.

The external Q.A. began after the first several weeks of analysis, this was done to get a "feel" for the concentration ranges for the elements of interest, so that the Q.A. program could be built around these ranges.

The procedure for external Q.A. consisted of submitting two Q.A. samples per week with each batch of samples. One sample was a known Q.A. sample in which no less than 2 nor no more than 3 elements were dictated by the Department for analysis. The other sample involved sacrificing one site per week as blind Q.A. sample. This site was altered from week to week. A list of Q.A. materials used follows:

TABLE 71

COMPARISON OF ELEMENTS MEASURED BY THE TWO PROCEDURES

	INAA	XRF
Na	x	
Mg	x	
Al	x	x
Si		x
Cl	x	x
K	x	x
Ca		x
Ti	x	x
V	x	x
Cr		x
Mn	x	x
Fe		x
Ni		x
Cu		x
Zn		x
Br	x	x
As		x
Ba	x	x
Pb		x
S		x

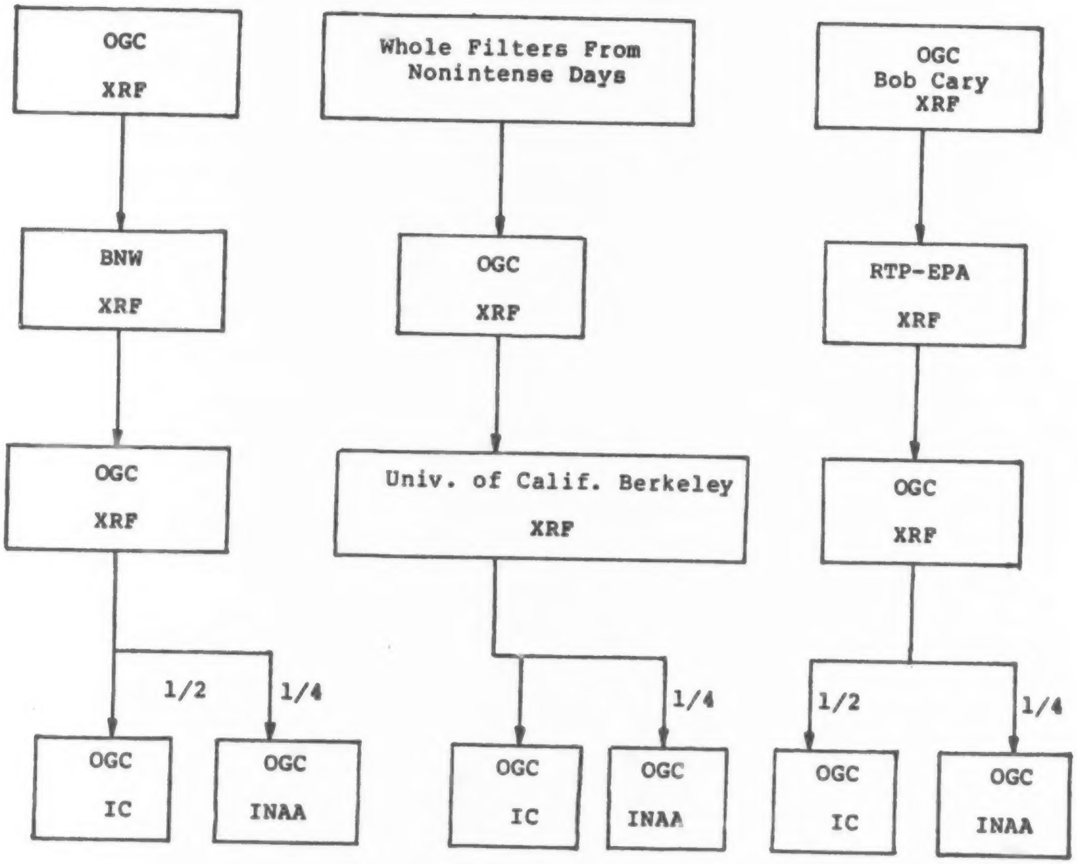
OGC
XRF
Whole Filters From Nonintense Days
OGC
Bob Cary
XRF
BNW
XRF
OGC
XRF
RTP-EPA
XRF
OGC
XRF
Univ. of Calif. Berkeley
XRF
OGC
XRF
1/2
1/4
1/4
1/2
1/4
OGC
IC
OGC
INAA
OGC
IC
OGC
INAA
OGC
IC
OGC
INAA

Figure 51. Schematic flow diagram of PACS Intermethod and interlaboratory comparison Q.A. program.

EPA Reference Samples

575 #1
575 #1 @ 1:10
575 #2 @ 1:10
776 #1
776 #1 @ 1:10
776 #2
776 #2 @ 1:10

Duplicate Analysis

Split-Spike Analysis

The Q.A. procedures stated above pertain specifically to the water samples; however, the precipitation and snow samples received basically the same Q.A. considerations.

1.4 Vegetation, Soil, and Sediment

With each batch of vegetative samples analyzed, the laboratory Q.A. consisted of analyzing duplicates, National Bureau of Standards - Standard Reference Materials, and spike recovery determinations.

The external Q.A., which comprised 10% of the elemental determinations, consisted of analyzing duplicates and SRM's. The following is a list of SRM's used.

SRM-1571 (Orchard Leaves)
SRM-1570 (Spinach)
SRM-1573 (Tomato Leaves)

Laboratory Q.A. for the soil and sediment analysis consisted of analyzing duplicates, Reference Soil # SO-3 from the Canadian Centre for Mineral and Energy Technology, plus spike recovery determinations. Duplicate analysis, making up 10% of the total elemental determinations, made up the external Q.A.

APPENDIX C

AN
ATMOSPHERIC TRANSPORT
AND DEPOSITION
COMPUTER MODEL

1. ATMOSPHERIC COMPUTER MODELING

The computer is a mathematical representation of the physical processes by which the atmosphere transports stack effluents downstream, mixes the effluents vertically and horizontally, and is cleansed by precipitation washout (wet deposition). Additional depletion of the air contaminants occurs by transformation to different forms, gravitational settling of particulates (dry deposition), and filtering by ground level obstructions (aerosol impaction) such as grasses, trees, and buildings.

The diffusion and deposition of air contaminants by the atmosphere occurs under diverse atmospheric conditions. Among these conditions are wind velocity, mixing depth (atmospheric boundary layer), vertical turbulence and temperature (stability), and rainfall duration and rate. These conditions vary from month-to-month, and the cumulative effects on diffusion and deposition using monthly averages of conditions can be different from annual averages of conditions.

A computer model provides a tool to determine the cumulative effect during a season or year of the diverse meteorological conditions. It also provides a computational capability to study the spacial patterns of air concentration and deposition surrounding a coal-fired facility or the combined effect of groups of facilities.

1.1 Model Selection and Development

The United States Environmental Protection Agency has adopted several levels of models as "standard reference" models for evaluation of concentrations of air contaminants ( ). However, these models do not address dryfall and wetfall deposition on ground level surfaces.

The techniques of an existing computer model were selected for this project. The theoretical development of the model, known as the Atmospheric Transport model, has been described by Culkowski, et al, 1976, and Mils, T. M. and M. Reeves, 1973. This model is a Gaussian plume model, common for its simpler technique and lower computer time requirements. The ATM output has been compared to ground level measurements, also reported by Culkowski, et al, 1976.

The techniques of the ATM model have been modified for this project. The resulting model has been called the Atmospheric Transport and Deposition Model (ATDM). The major modifications are:

1) wind speed profile - added a vertical wind profile formula to account for increasing wind speeds with height ( ),

2) plume rise - added a program function to compute plume rise by plume buoyancy and momentum according to the procedure of Brigg ( ),

3) boundary layer - added a data block for monthly and annual climatic heights of the boundary layer which was based on an analysis of five years of atmospheric soundings taken at Bismarck with the CRSTER meteorological preprocessing program,

4) dispersion coefficients - restrict vertical dispersion coefficients by the height of the planetary boundary layer,

5) mean wind speed - modified the central wind speeds of the six wind speed classes using five years of wind observations taken at Bismarck,

6) wetfall - added monthly and annual climatic parameters of rainfall duration and rate based upon historical records of nine recording rain gauges surrounding the project study area, and

7) receptors - added a capability for a gridded network or randomly distributed network of surface receptors so that area-wide maps of air concentration and deposition could be drawn for the study area.

The resulting model is applicable for an assumed straight-line wind direction at source-receptor distances less than 100 km. Wetfall deposition occurs by precipitation scavenging of air contaminants as precipitation elements (raindrops, etc.) fall through the planetary boundary layer and by collection of air contaminants during the formation of the elements. Since the formation of precipitation generally occurs at heights above the boundary layer, the process has not been included in the model.

2. INPUT TO THE MODEL

Input into the Atmospheric Transport and Deposition Model (ATDM) consists of three types. One type, the climatological data, is stored internally within the model or a computer disk file and the other two types are input by computer cards.

The climatological data is structured around the time cycle of one month or one year. Successive months can be grouped to form seasons. Table 72 lists the climatological data base in the model and the time cycle of each parameter. Those parameters provided only as an annual average condition are assumed valid for monthly or seasonal time cycles.

Sensitivity testing of ATDM indicated that an execution based upon the twelve months versus an annual representation of meteorological conditions provided ambient air surface concentrations and rates of deposition which differed by more than 10 percent, depending upon receptor location. Therefore, annual representations of atmospheric parameters should be used only when computer cost-efficiency becomes a significant consideration.

TABLE 72

CLIMATOLOGICAL PARAMETERS FOR WHICH DATA IS LOCATED WITHIN ATDM

Parameter	Time Cycle
Joint Wind Frequency - by stability class, wind speed class	Monthly, Annual
Mean Atmospheric Surface Temperature (°K)	Monthly, Annual
Mean Rainfall Rate (inches/hour)	Monthly, Annual
Joint Rainfall Duration Frequency	Monthly, Annual
Mean Height of Atmospheric Boundary Layer (meters) - by stability class	Monthly, Annual
Mean Central Surface Wind Speed (meters/second) - by wind speed class, stability class	Annual
Exponentials for Above Surface Wind Speeds - by wind speed class	Annual

Nine input data blocks from computer cards provide program option control, emission source parameters, and receptor parameters. These data blocks are described below and are clearly identified within the source program.

Card Input Block 1 ATITLE

Eighty character title of the computer execution which is printed on the top of each page of output data.

Card Input Block 2 NPS, NPOL, IFILE, FMON, NMON

NPS = number of point sources from which air concentrations and deposition will be calculated. The minimum number is 1 and the maximum number has been limited to 20.

NPOL = number of air contaminants emitted by sources for which air concentration and deposition will be calculated. The minimum number is one and the maximum number has been limited to three. If two are entered, the model assumes that both are the same contaminant, but one is vapor form and the other is particulate form; it then adds the two to obtain the total air concentration and deposition of the contaminant.

IFILE = computer disk file number of desired joint wind frequency file. Five files are available; one for each of the four first order National Weather Service Stations in Western North Dakota and a composite average of the four. The file numbers range from eleven to fifteen.

FMON = the first month of the time base for calculation with January as 1, etc. If annual climatological data are desired, set FMON equal to 13.

NMON = number of successive months; 1 for one month, etc. If annual climatological data are used, set NMON equal to 1.

Card Input Block 3 TILT, KDISP, CV

TILT = control variable for tilting plume due to particle settling by gravitation. When TILT equals 1, the depth of the plume is adjusted for gravitational settling as downstream distance increases.

DKISP = control variable for calculation of vertical dispersion coefficients (SIGMA). When set equal 1, Pasquill-Gifford stability parameters are used from data block: when set equal to 2, Hosker's formulation of Briggs-Smith dispersion parameters are calculated.

CV = a factor for conversion of receptor coordinates to meters. For example, when receptor and source coordinates are in units of miles, then CV equals 1,609.8.

Card Input Block 4 NSC, JSTD(NSC)

NSC = number of stability classes; varies from 1 to 6. Normally, NSC equals 6; however, any one or combination of the six stability classes can be chosen for special purposes such as model validation studies.

JSTB = a list of the stability classes for which calculations will be performed. Stability class A corresponds to 1, etc.

Card Input Block 5 NDIR, WDDIR(NDIR)

NDIR = number of wind directions; varies from 1 to 16. Normally NDIR equals 16; however, any one or combination of wind directions can be chosen.

WDDIR = a list of the wind speed directions for which calculations will be performed. 1 corresponds to winds blowing from the north-northeast (NNE), 2 corresponds to winds blowing from the northeast (NE), etc.

Card Input Block 6 SX, SY, SHT, SDIA, SEVL, SGT, ANPS

One computer card for each source:

SX = X cartesian coordinate location of the source (miles, kilometers, nautical miles, etc.)

SY = Y cartesian coordinate location of the source (must be same units as SX).

SHT = the stack height of the source in units of meters.

SDIA = the diameter of the stack at its top in units of meters.

SEVL = the speed of flow of the stack flue gas out the stack in units of meters per second.

SGT = the temperature of the stack flue gas in units of degrees Kelvin.

ANPS = an eight character name identifying the source.

Card Input Block 7 ITYPE, DIAM, DENS, ERATE

ITYPE = control variable identifying the form of the contaminants as particulate (ITYPE = 1) or vapor (ITYPE = 2).

DIAM = mean mass diameter of particulate in units of micrometers.

DENS = density of particulate in units of grams per cubic centimeter if ITYPE equals 1, or diffusivity of air in units of meters squared per second if ITYPE equals 2.

ERATE = the emission rate of the air contaminant from the stack in units of grams per second. ERATE is assumed constant from month-to-month.

Card Input Block 8 FX,FY, AX,AY, DTA

FX,FY = the first X and Y, respectively, cartesian coordinate location of a grid of receptors. The program assumes FX,FY to be located at the lower left corner of the grid.

AX,AY = the last X and Y, respectively, cartesian coordinate location of a grid of receptors. The program assumes AX,AY to be located at the upper right corner of the grid.

DTA = the spacing interval of grid lines from FX,FY to AX,AY.

The units of FX,FY, AX,AY, and DTA must be the same as the units of SX and SY. Additional cards can be used to increase the density of receptors at locations within a larger grid, or a second card can be used to produce a honeycomb grid formation of receptor locations.

Card input block 8 can be omitted; however, it must be followed by a blank control card.

Card Input Block 9 RX,RY, NROSE

RX,RY = the X and Y, respectively, cartesian location of a specific receptor.

NROSE = control parameter, when equal to 1, will provide a source contribution rose of the air contaminant at the receptor.

Card input block 9 can be omitted when card input block 8 is used. Block 9 comprises one card for each receptor. A trailing control card should not be use.

3. SOURCE LISTING

A source listing at the computer model is shown on the following pages.

4. MODEL OUTPUT

The output listing of the model includes tables of all input parameters for calculations and a table of calculated air concentrations and deposition at each receptor location. An example is shown on the following pages.

The air concentrations, deposition, and corresponding receptor locations, are stored on computer disk for isopleth plotting analysis by other computer routines.

Source Listing of ATDM

```
//HLOF220  JOB '01-301-40-MODEL*TRAC*ELEM',MSGCLASS=1,CLASS=F,
//            TIME=3
//STEP1    EXEC FRTCOM,PROGNM=HL1226,
//                  PARM.FORT='XREF,MAP,LINECNT=84,SIZE=600K'
//FORT.SYSPRINT DD SYSOUT=1
//FORT.SYSIN DD *
C****
C     MAIN PROGRAM FOR AN ATMOSPHERIC TRANSPORT AND DEPOSITION MODEL#
C     THIS PROGRAM AND SUPPORTING FUNCTIONS AND SUBROUTINES
C     WERE DEVELOPED BY MARTIN R. SCHOCK DURING JANUARY,1978,
C     FOR THE NORTH DAKOTA STATE DEPARTMENT OF HEALTH FROM
C     PREVIOUS WORK BY THE OAK RIDGE NATIONAL LABORATORY (ONRL
C     /NSF/EATC-17) AND THE ENVIRONMENTAL PROTECTION AGENCY
C     (EPA-R4-73-024).
C****
      INTEGER TILT,OUT,STOR,WDDIR,FMON
      REAL MAT
      DEFINE FILE 11(1248,49,E,IC),12(1248,49,E,IC),13(1248,49,E,IC),
     114(1248,49,E,IC),15(1248,49,E,IC)
      DIMENSION ATITLE(20),MONTH(13),WND(6)
      DIMENSION FRDEP(16,3),FRCON(16,3),TOTDEP(3),CONC(3),ANPS(20,2)
      COMMON/C1/XM(50),SIGCOF(6,50),SIGMAX(6),KDISP,IKPM,ROUGH
      COMMON/C2/COVER(13),MAT(13),RBAR(13),RNFR(13),
     1HT(6,13),WNDSP(6,6)
      COMMON/C3/CV
      COMMON/C4/WNDFRQ(6,6,16,13),RNFRQ(6,16,13),FMON,NMON
      COMMON/C5/NPS,ITYPE(20,3),DIAM(20,3),DENS(20,3),ERATE(20,3),
     1SX(20),SY(20),SHT(20),SDIA(20),SEVL(20),SGT(20)
      COMMON/C6/RX,RY,TDRY(16),TWET(16),CON(16),SIGTAB(6,50),
     1NSC,JSTB(6),NDIR,WDDIR(16)
      COMMON/C7/IX,FDV(20,3),FLAMDA(20,3,13),FLSPD(20,3)
      DATA MONTH/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG',
     1'SEP','OCT','NOV','DEC','ANN'/
      DATA INN,OUT,STOR/5,6,7/
      DATA IPG/70/
C
C****READ CARD 1 * * * OUTPUT HEADER TITLE * * *
      READ(INN,501)(ATITLE(IM),IM=1,20)
  501 FORMAT(20A4)
      WRITE(OUT,601)(ATITLE(IM),IM=1,20)
  601 FORMAT('1',/////,1X,20A4,//)
C
C****READ CARD 2 * * * NUMBER OF/POINT SOURCES, POLLUTANTS/,
C     STAR DECKS/FILE NUMBER, FIRST MONTH (MONTH 13 IS ANNUAL AVERAGE),
C     NUMBER OF MONTHS/ * * *
      READ (INN,502) NPS,NPOL,IFILE,FMON,NMON
  502 FORMAT (5I5)
      FNMON=NMON
      NMON=FMON+NMON-1
C
C****READ CARD 3 * * * OPTIONS FOR/ PLUME TILT, DISPERSION COEFFICIENT/
C     AND RECEPTOR UNITS CONVERSION FACTOR (M/KM OR M/MI) * * *
      READ(INN,504)TILT,KDISP,CV
  504 FORMAT(2I5,F7.0)
      WRITE(OUT,602)CV
  602 FORMAT('0','THE GRID CONVERSION FACTOR (CV)#',F7.1)
C
C
      WRITE(OUT,603)TILT
  603 FORMAT('0',/,' DRY DEPOSITION PARAMETERS#',//,' THE SLOPING PLUME
     1OPTION FOR PARTICLES (TILT)#',I3)
C****READ DATA BLOCK * * * COEFFICIENTS FOR SURFACE COVER * * *
      WRITE(OUT,604)(MONTH(M),COVER(M),M=FMON,NMON)
  604 FORMAT('0',12X,'SURFACE',/,3X,'PERIOD      COVER',13(/,5X,A3,7X,
     1F3.0))
C
C****READ DATA BLOCK * * * AVERAGE RAINFALL RATE (IN/HR), AVERAGE
C     RAINFALL DURATION * * *
      WRITE(OUT,605)(MONTH(M),RBAR(M),RNFR(M),M=FMON,NMON)
  605 FORMAT('0',/,' WET DEPOSITION PARAMETERS#',//,13X,'AVERAGE RAINFAL
     1L   FRACTION OF TIME',/,3X,'PERIOD',6X,'RATE (IN/HR)',8X,'RAIN OCC
     2URS',13(/,5X,A3,7X,F7.3,13X,F7.3))
C
C
      DO101M=FMON,NMON
      RBAR(M)=RBAR(M)*25.4
      DO101J=1,6
      DO101L=1,16
      RNFRQ(J,L,M)=RNFR(M)
  101 CONTINUE
C
C****READ CARD 4 * * * NUMBER OF STABILITY CLASSES, THE CLASSES
C     (1 THROUGH 7) * * *
      READ(INN,506)NSC,(JSTB(I),I=1,NSC)
  506 FORMAT(8I4)
      WRITE(OUT,606)NSC,(JSTB(I),I=1,NSC)
  606 FORMAT('0','THE NUMBER OF STABILITY CLASSES AND STABILITIES USED#'
     1,I3,'+',5(I2,','),I2)
C
C****READ CARD 5 * * * NUMBER OF WIND DIRECTIONS, THE DIRECTIONS
C     (1 THROUGH 16) * * *
      READ(INN,507)NDIR,(WDDIR(IM),IM=1,NDIR)
  507 FORMAT(17I4)
      WRITE(OUT,607)NDIR,(WDDIR(IM),IM=1,NDIR)
  607 FORMAT('0','THE NUMBER OF WIND DIRECTIONS AND DIRECTIONS USED#',I3
     1,'+',8(I2,','),/,55X,7(I2,','),I2)
C
      WRITE(OUT,601) (ATITLE(IM),IM=1,20)
      WRITE(OUT,6071)KDISP
 6071 FORMAT('0','THE DISPERSION COEFFICIENTS OPTION (KDISP)#',I3)
C****READ DATA BLOCK * * * COEFFICIENT FOR SURFACE ROUGHNESS
C     (METERS) * * *
      WRITE(OUT,6072)ROUGH
 6072 FORMAT('0',/,' THE EFFECTIVE SURFACE ROUGHNESS (ROUGH)#',F5.2,/)
C****READ DATA BLOCK * * * DISPERSION COEFFICIENTS (METERS) * * *
      WRITE(OUT,608) (N,N=1,6)
  608 FORMAT('0','DISTANCE',24X,'VERTICAL DISPERSION COEFFICIENTS (METER
     1S)',//,3X,'(M)',9X,'SC',I1,5(12X,'SC',I1),/)
      DO104IM=1,50
      DO103I=1,6
      IF(KDISP.EQ.1) GOTO102
      SIGTAB(I,IM)=SGMA(I,XM(IM))
      GO TO 103
  102 SIGTAB(I,IM)=SIGCOF(I,IM)
  103 CONTINUE
      WRITE(OUT,609) XM(IM),(SIGTAB(I,IM),I=1,6)
  609 FORMAT(' ',F7.0,6E15.5)
  104 CONTINUE
```

```
C
C****READ DATA BLOCK * * * MIXING HEIGHTS (METERS) * * *
      WRITE(OUT,601) (ATITLE(IM),IM=1,20)
      WRITE(OUT,6091)(N,N=1,6)
 6091 FORMAT('0',//,33X,'MIXING HEIGHTS (METERS)',//,' PERIOD       SC',
     1I2,5(7X,'SC',I2),/)
      DO105M=FMON,NMON
      WRITE(OUT,6092)MONTH(M),(HT(J,M),J=1,6)
 6092 FORMAT(' ',/,3X,A3,7X,F6.0,5(5X,F6.0))
  105 CONTINUE
C
C****READ DATA BLOCK * * * MEAN ATMOSPHERIC TEMPERATURE (DEG K) * * *
      WRITE(OUT,6093)(MONTH(M),MAT(M),M=FMON,NMON)
 6093 FORMAT('0',///,13X,'MEAN ATMOSPHERIC',/,3X,'PERIOD     TEMPERATURE
     1 (K)',13(/,5X,A3,9X,F6.1))
C
C****READ DATA BLOCK * * * CENTRAL WIND SPEEDS (M/SEC) * * *
      WRITE(OUT,6094)(J,J=1,6)
 6094 FORMAT('0',///,24X,'CENTRAL WIND SPEEDS (M/SEC)',//,'  WIND SPEED'
     1,4X,'---------------------- STABILITY CLASS ----------------------',
     2/,4X,'CLASS',6(7X,'SC',I2),/)
      WRITE(OUT,6095)(K,(WNDSP(J,K),J=1,6),K=1,6)
 6095 FORMAT(' ',6(5X,I2,7X,F5.2,6X,F5.2,6X,F5.2,6X,F5.2,6X,F5.2,6X,
     1F5.2,/))
C
C****READ DISK * * * STAR DATA * * *
      IC=(FMON-1)*96+1
      DO106M=FMON,NMON
      DO106J=1,6
      DO106L=1,16
      READ (IFILE'IC,508) (WND(K),K=1,6)
  508 FORMAT(7X,6F7.0)
      DO106K=1,6
      WNDFRQ(J,K,L,M)=WND(K)/FNMON
  106 CONTINUE
C
      DO1107MM=FMON,NMON
      TATAL=0.
      DO107M=1,2
      WRITE(OUT,601)(ATITLE(IM),IM=1,20)
      WRITE(OUT,610)MONTH(MM),(N,N=1,6)
  610 FORMAT('0',/,' TIME PERIOD# ',A3,///,' SECTOR    WSC',I2,5(15X,'WS
     1C',I2))
      IB=M*3
      IA=IB-2
      DO107J=IA,IB
      WRITE(OUT,611)J
  611 FORMAT('0',38X,'THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS',
     1I3,/)
      DO107L=1,16
      WRITE(OUT,612)L,(WNDFRQ(J,K,L,MM),K=1,6)
  612 FORMAT(' ',I2,6E20.6)
      DO107K=1,6
      TATAL=TATAL+WNDFRQ(J,K,L,MM)
  107 CONTINUE
 1107 WRITE(OUT,613) TATAL
  613 FORMAT('0',/,' THE SUM OF ALL OF THE ABOVE JOINT WIND FREQUENCIES
     1IS#',F9.6)
C
```

```
C****READ CARD 6 (NPS) * * * POINT SOURCE/X COORDINATE (KM OR MI),
C     Y COORDINATE (KM OR MI), STACK HEIGHT (M), STACK DIAMETER (M),
C     STACK GAS VELOCITY (M/SEC), STACK GAS TEMPERATURE (DEG K), NAME/
C     * * *
      DO108I=1,NPS
      READ(INN,509)SX(I),SY(I),SHT(I),SDIA(I),SEVL(I),SGT(I),(ANPS(I,K),
     1K=1,2)
  509 FORMAT(6F7.0,8X,2A4)
  108 CONTINUE
C
C****READ CARD  7 (NPS * NPOL) * * * SOURCE EMISSION PARAMETERS/TYPE
C     (PARTICULATE = 1 OR GAS = 2), PARTICLE DIAMETER (MICRONS),
C     PARTICULATE DENSITY (GM/M**3) OR GAS DIFFUSIVITY (M**2/SEC), EMIS-
C     SION RATE (GM/SEC)/ * * *
      DO109I=1,NPS
      DO109IX=1,NPOL
      READ(INN,510)ITYPE(I,IX),DIAM(I,IX),DENS(I,IX),ERATE(I,IX)
  510 FORMAT(I5,3F7.0)
  109 CONTINUE
C
      WRITE(OUT,601)(ATITLE(IX),IX=1,20)
      WRITE(OUT,614)
  614 FORMAT('0','THE POINT SOURCE EMISSION PARAMETERS#',/,5X,'LOCATION'
     1,4X,'---------------- STACK ---------------',/,17X,'HEIGHT   DIAME
     2TER   GAS VEL   GAS TEMP',/,4X,'X',6X,'Y',8X,'M',9X,'M',7X,'M/SEC'
     3,5X,'DEG K')
      WRITE(OUT,615)
  615 FORMAT(' ',60X,'--------- POLLUTANT --------',/,61X,'TYPE    DIAM
     1   DEN     RATE',/,70X,'U    G/M**3   G/SEC')
      DO110I=1,NPS
      WRITE(OUT,616)(ANPS(I,K),K=1,2)
  616 FORMAT('0',2A4,' --------')
      WRITE(OUT,617)SX(I),SY(I),SHT(I),SDIA(I),SEVL(I),SGT(I)
  617 FORMAT(/,2F7.2,4X,F4.0,5X,F5.1,5X,F5.1,6X,F5.0)
      DO110IX=1,NPOL
      WRITE(OUT,618)ITYPE(I,IX),DIAM(I,IX),DENS(I,IX),ERATE(I,IX)
  618 FORMAT(62X,I2,4X,F5.1,2X,F5.1,2X,E9.3)
  110 CONTINUE
C
C****INITIALIZE DATA FIELDS TO REDUCE CALCULATION TIME
      DO113I=1,NPS
      DO113IX=1,NPOL
C
      FDV(I,IX)=DVEL(ITYPE(I,IX),DIAM(I,IX),DENS(I,IX))
      DO112M=FMON,NMON
  112 FLAMDA(I,IX,M)=WASH(ITYPE(I,IX),DIAM(I,IX),DENS(I,IX),RBAR(M))
C
      IF(TILT.NE.1) GOTO111
      IF(ITYPE(I,IX).EQ.2) GOTO111
      FLSPD(I,IX)=(.003*DENS(I,IX)*DIAM(I,IX)*DIAM(I,IX))/100.
      GOTO113
  111 FLSPD(I,IX)=0.
  113 CONTINUE
C
      DO114IX=1,3
      TOTDEP(IX)=0.
      CONC(IX)=0.
  114 CONTINUE
C
```

```
C
C****READ CARD  8 (1 OR MORE/FOLLOWED BY A BLANK CARD) * * * RECEPTOR
C     GRID (UNITS OF KM OR MI)/SOUTHWEST X COORDINATE, SOUTHWEST Y
C     COORDINATE, NORTHEAST X COORDINATE, NORTHEAST Y COORDINATE,
C     INTERVAL/ * * *
  115 READ(INN,511)FX,FY,AX,AY,DTA
  511 FORMAT(5X,5F5.0)
      IF(DTA.LE.0.) GOTO118
C
      NROSE=0
      CNX=0.
  116 RX=FX+CNX*DTA
      IF(RX.GT.AX) GOTO115
      CNX=CNX+1.
      CNY=0.
  117 RY=AY-CNY*DTA
      IF(RY.LT.FY) GOTO116
      CNY=CNY+1.
      GOTO119
C
C****READ CARD  9 (ONE FOR EACH RECEPTOR) * * * RECEPTOR LOCATION
C     (UNITS OF KM OR MI)/X COORDINATE, Y COORDINATE/ OPTION FOR
C     CONCENTRATION AND DEPOSITION ROSE (1 = PRINT) * * *
  118 READ(INN,512,END=707)RX,RY.NROSE
  512 FORMAT(2F8.2,I5)
C
  119 IPGM=0
      IF(NROSE.EQ.1) IPGM=4+(2*NPOL)
      IPGM=70-IPGM
      IF(IPG.LT.IPGM) GOTO120
      IPG=0
      WRITE(OUT,619)(ATITLE(IM),IM=1,20)
  619 FORMAT('1',///20X,20A4,//)
      WRITE(OUT,620)
  620 FORMAT(' ',6X,'RECEPTOR LOCATION',4X,'POLLUTANT',8X,'DRYDEP',8X,'W
     1ETDEP',7X,'TOTAL DEP',7X,'CONC')
      WRITE(OUT,621)
  621 FORMAT(' ',10X,'X',8X,'Y',21X,'UG/M**2/SEC',3X,'UG/M**2/SEC',4X,'U
     1G/M**2/SEC',4X,'UG/M**3',//)
C
  120 IPG=IPG+1+NPOL
      DO125IX=1,NPOL
      TOTDRY=0.
      TOTWET=0.
      CONC(IX)=0.
C
      CALL DEPSN
C
      DO121IM=1,NDIR
      TOTDRY=TOTDRY+TDRY(IM)
      TOTWET=TOTWET+TWET(IM)
  121 CONC(IX)=CONC(IX)+CON(IM)
      TOTDEP(IX)=TOTDRY+TOTWET
      WRITE(OUT,622)RX,RY,IX,TOTDRY,TOTWET,TOTDEP(IX),CONC(IX)
  622 FORMAT(4X,2F9.2,7X,I3,6X,4E14.3)
C
      IF(NROSE.NE.1) GOTO125
      DO124IM=1,NDIR
      IF(TOTDEP(IX).LE.0.) GOTO122
      FRDEP(IM,IX)=(TDRY(IM)+TWET(IM))/TOTDEP(IX)
      GOTO123
  122 FRDEP(IM,IX)=0.
  123 FRCON(IM,IX)=CON(IM)/CONC(IX)
  124 CONTINUE
C
  125 CONTINUE
C
      GO TO (1251,1271,128), NPOL
C
 1251 IF(TOTDEP(1).LE.0.) GOTO126
      RATIO=(TOTDRY/TOTDEP(1))*100.
      GOTO127
  126 RATIO=0.
  127 WRITE(STOR,703) RX,RY,TOTDEP(1),CONC(1),TOTDRY,TOTWET,RATIO
  703 FORMAT(2F8.2,4X,2E10.4,10X,3E10.4)
      GOTO129
C
 1271 IPG=IPG+1
      TOTDEP(3)=TOTDEP(1)+TOTDEP(2)
      CONC(3)=CONC(1)+CONC(2)
      WRITE(OUT,6622) TOTDEP(3),CONC(3)
 6622 FORMAT(66X,2E14.3)
C
  128 WRITE(STOR,705)RX,RY,(TOTDEP(IX),CONC(IX),IX=1,3)
  705 FORMAT(2F8.2,4X,6E10.4)
C
  129 IF(NROSE.NE.1) GOTO132
      IPG=IPG+4+(2*NPOL)
      WRITE(OUT,623)
  623 FORMAT('0','POLLUTANT',46X,'---- DEPOSITION ROSE ----')
      DO130IX=1,NPOL
      WRITE(OUT,624)IX,(FRDEP(IM,IX),IM=1,NDIR)
  624 FORMAT(' ',4X,I2,4X,16(2X,F5.2))
  130 CONTINUE
      WRITE(OUT,625)
  625 FORMAT('0','POLLUTANT',44X,'---- CONCENTRATION ROSE ----')
      DO131IX=1,NPOL
      WRITE(OUT,624)IX,(FRCON(IM,IX),IM=1,NDIR)
  131 CONTINUE
C
  132 WRITE(OUT,626)
  626 FORMAT(' ')
      IF(DTA.LE.0.) GOTO118
      GOTO117
  707 END FILE STOR
      CALL EXIT
      STOP
      END
      BLOCK DATA
      REAL MAT
      DIMENSION SIG1(6,19),SIG2(6,19),SIG3(6,12)
      COMMON/C1/XM(50),SIGCOF(6,50),SIGMAX(6),KDISP,IKPM,ROUGH
      COMMON/C2/COVER(13),MAT(13),RBAR(13),RNFR(13),
     1HT(6,13),WNDSP(6,6)
      EQUIVALENCE (SIGCOF(1,1),SIG1(1,1)),(SIGCOF(1,20),
     1  SIG2(1,1)),(SIGCOF(1,39),SIG3(1,1))
      DATA ROUGH/0.1/
      DATA COVER/1.,1.,1.,2.,2.,3.,3.,3.,3.,3.,2.,2.,2./
 DATA SIGMAX/6*0.5E4/
 DATA XM/
&  1.0E+00,2.0E+00,3.0E+00,4.0E+00,5.0E+00,
&  1.0E+01,1.5E+01,2.0E+01,2.5E+01,3.0E+01,
&  3.5E+01,4.0E+01,4.5E+01,5.0E+01,1.5E+02,
&  2.0E+02,3.0E+02,4.0E+02,5.0E+02,6.0E+02,
&  7.0E+02,8.0E+02,9.0E+02,1.0E+03,1.1E+03,
&  1.2E+03,1.3E+03,1.4E+03,1.6E+03,1.8E+03,
&  2.0E+03,2.5E+03,3.0E+03,3.5E+03,4.0E+03,
&  4.5E+03,5.0E+03,6.0E+03,7.0E+03,8.0E+03,
&  1.0E+04,1.5E+04,2.0E+04,3.0E+04,4.0E+04,
&  5.0E+04,6.0E+04,7.0E+04,8.0E+04,1.0E+05/
 DATA SIG1/
&  7.963E-02,1.000E-01,1.070E-01,9.319E-02,4.744E-02,1.924E-02,
&  1.752E-01,2.000E-01,2.025E-01,1.681E-01,8.856E-02,3.743E-02,
&  2.778E-01,3.000E-01,2.941E-01,2.374E-01,1.276E-01,5.524E-02,
&  3.854E-01,4.000E-01,3.832E-01,3.033E-01,1.653E-01,7.282E-02,
&  4.968E-01,5.000E-01,4.704E-01,3.668E-01,2.021E-01,9.021E-02,
&  1.093E+00,1.000E+00,8.900E-01,6.618E-01,3.773E-01,1.755E-01,
&  1.733E+00,1.500E+00,1.292E+00,9.346E-01,5.435E-01,2.590E-01,
&  2.404E+00,2.000E+00,1.684E+00,1.194E+00,7.042E-01,3.413E-01,
&  3.099E+00,2.500E+00,2.067E+00,1.444E+00,8.610E-01,4.229E-01,
&  3.813E+00,3.000E+00,2.445E+00,1.686E+00,1.015E+00,5.037E-01,
&  4.544E+00,3.500E+00,2.817E+00,1.923E+00,1.166E+00,5.841E-01,
&  5.290E+00,4.000E+00,3.186E+00,2.154E+00,1.313E+00,6.639E-01,
&  6.048E+00,4.500E+00,3.550E+00,2.382E+00,1.462E+00,7.434E-01,
&  6.818E+00,5.000E+00,3.912E+00,2.605E+00,1.607E+00,8.225E-01,
&  2.379E+01,1.500E+01,1.075E+01,6.638E+00,4.322E+00,2.361E+00,
&  3.300E+01,2.000E+01,1.400E+01,8.480E+00,5.600E+00,3.112E+00,
&  6.255E+01,3.129E+01,2.053E+01,1.198E+01,8.129E+00,4.593E+00,
&  9.847E+01,4.299E+01,2.694E+01,1.530E+01,1.059E+01,6.054E+00,
&  1.400E+02,5.500E+01,3.326E+01,1.850E+01,1.300E+01,7.500E+00/
 DATA SIG2/
&  2.113E+02,6.965E+01,3.951E+01,2.137E+01,1.493E+01,8.720E+00,
&  2.994E+02,8.505E+01,4.570E+01,2.414E+01,1.678E+01,9.904E+00,
&  4.047E+02,1.011E+02,5.184E+01,2.682E+01,1.857E+01,1.106E+01,
&  5.281E+02,1.178E+02,5.794E+01,2.944E+01,2.031E+01,1.219E+01,
&  6.696E+02,1.350E+02,6.400E+01,3.200E+01,2.200E+01,1.330E+01,
&  9.152E+02,1.562E+02,6.962E+01,3.421E+01,2.345E+01,1.430E+01,
&  1.217E+03,1.785E+02,7.517E+01,3.636E+01,2.486E+01,1.527E+01,
&  1.583E+03,2.017E+02,8.068E+01,3.846E+01,2.623E+01,1.623E+01,
&  2.018E+03,2.259E+02,8.613E+01,4.050E+01,2.756E+01,1.717E+01,
&  3.126E+03,2.772E+02,9.690E+01,4.448E+01,3.014E+01,1.900E+01,
&  4.599E+03,3.319E+02,1.075E+02,4.830E+01,3.261E+01,2.077E+01,
&  6.500E+03,3.900E+02,1.180E+02,5.200E+01,3.500E+01,2.250E+01,
&  1.844E+04,6.131E+02,1.421E+02,6.022E+01,3.991E+01,2.506E+01,
&  4.321E+04,8.874E+02,1.653E+02,6.789E+01,4.443E+01,2.736E+01,
&  8.880E+04,1.213E+03,1.879E+02,7.514E+01,4.864E+01,2.947E+01,
&  1.657E+05,1.590E+03,2.100E+02,8.203E+01,5.262E+01,3.143E+01,
&  2.873E+05,2.019E+03,2.316E+02,8.864E+01,5.639E+01,3.327E+01,
&  4.700E+05,2.500E+03,2.528E+02,9.500E+01,6.000E+01,3.500E+01,
&  1.925E+06,3.818E+03,2.942E+02,1.052E+02,6.576E+01,3.782E+01/
 DATA SIG3/
&  6.340E+06,5.461E+03,3.345E+02,1.147E+02,7.105E+01,4.038E+01,
&  1.781E+07,7.445E+03,3.738E+02,1.236E+02,7.598E+01,4.274E+01,
&  1.000E+08,1.250E+04,4.500E+02,1.400E+02,8.500E+01,4.700E+01,
&  4.300E+09,3.835E+04,6.161E+02,1.750E+02,9.884E+01,5.422E+01,
&  6.200E+10,8.499E+04,7.700E+02,2.050E+02,1.100E+02,6.000E+01,
&  2.666E+12,2.415E+05,1.003E+03,2.479E+02,1.254E+02,6.645E+01,
     & 3.844E+13,5.066E+05,1.210E+03,2.837E+02,1.376E+02,7.145E+01,
     & 3.046E+14,9.000E+05,1.400E+03,3.150E+02,1.479E+02,7.558E+01,
     & 1.653E+15,2.357E+06,1.556E+03,3.480E+02,1.569E+02,7.913E+01,
     & 6.906E+15,5.321E+06,1.705E+03,3.786E+02,1.649E+02,8.227E+01,
     & 2.383E+16,1.077E+07,1.843E+03,4.072E+02,1.721E+02,8.508E+01,
     & 1.889E+17,3.500E+07,2.100E+03,4.600E+02,1.850E+02,9.000E+01/
      DATA RBAR/0.09,0.10,0.11,0.13,0.16,0.21,0.19,0.19,0.14,0.11,
     & 0.09,0.09,0.13/
      DATA RNFR/0.023,0.032,0.044,0.053,0.055,0.054,0.028,0.027,
     & 0.031,0.026,0.015,0.018,0.033/
      DATA HT/0.,293.,354., 390.,431.,429.,
     &         0.,418.,501.,504.,592.,600.,
     &       486.,924.,936.,885.,961.,1166.,
     &      1113.,1835.,1749.,1437.,1733.,1932.,
     &      1518.,1655.,1554.,1409.,1723.,1973.,
     &      1889.,1675.,1549.,1330.,1530.,1822.,
     &      1773.,1727.,1582.,1440.,1631.,1664.,
     &      1840.,1925.,1630.,1525.,1615.,1880.,
     &      2184.,1616.,1295.,1116.,1318.,1519.,
     &      1023.,1194.,1082.,1014.,1203.,1342.,
     &         0.,523.,629.,621.,751.,753.,
     &         0.,335.,293.,350.,392.,382.,
     &      1658.,1589.,1255.,1261.,1108.,1216./
      DATA WNDSP/0.8 ,0.95,0.95,0.95,0.9 ,0.85,
     &           2.25,2.55,2.55,2.55,2.50,2.50,
     &           0.  ,3.95,4.23,4.48,4.15,4.05,
     &           0.  ,0.  ,6.85,6.75,6.85,5.90,
     &           0.  ,0.  ,9.50,9.40,9.20,0.  ,
     &           0.  ,0.  ,12.1,12.3,0.  ,0.  /
      DATA MAT/261.7,262.8,269.3,279.2,285.7,290.9,294.5,293.4,287.5,
     & 281.3,271.4,264.0,278.5/
      END
C****
C     SUBROUTINE DEPSN CALCULATES THE DRYFALL, WETFALL, AND SURFACE
C     CONCENTRATIONS FROM ALL SOURCES FOR GIVEN STABILITY CLASSES
C     AND WIND DIRECTIONS
C****
      SUBROUTINE DEPSN
      INTEGER WDDIR,FMON
      REAL LAMDA,MAT
      DIMENSION UE(6)
      DIMENSION FX(50),XX(50)
      COMMON/C1/XM(50),SIGCOF(6,50),SIGMAX(6),KDISP,IKPM,ROUGH
      COMMON/C2/COVER(13),MAT(13),RBAR(13),RNFR(13),
     1HT(6,13),WNDSP(6,6)
      COMMON/C3/CV
      COMMON/C4/WNDFRQ(6,6,16,13),RNFRQ(6,16,13),FMON,NMON
      COMMON/C5/NPS,ITYPE(20,3),DIAM(20,3),DENS(20,3),ERATE(20,3),
     1SX(20),SY(20),SHT(20),SDIA(20),SFVL(20),SGT(20)
      COMMON/C6/RX,RY,TDRY(16),TWET(16),CON(16),SIGTAB(6,50),
     1NSC,JSTB(6),NDIR,WDDIR(16)
      COMMON/C7/IX,FDV(20,3),FLAMDA(20,3,13),FLSPD(20,3)
      DATA UE/0.1,0.15,0.2,0.25,0.25,0.3/
      DATA YCON/.1E07/
C
      DISMIN=150.
      IK=15
      IP=IK+1
C
```

```
      DO110M=1,NDIR
      TDRY(M)=0.
      TWET(M)=0.
      CON(M)=0.
  110 CONTINUE
C
      DO400I=1,NPS
C
      DV=FDV(I,IX)
      FLVEL=FLSPD(I,IX)
C
      DO400M=1,NDIR
      L=WDDIR(M)
C
      DIS=DIST(SX(I),SY(I),RX,RY,L)
      IF(DIS.LT.DISMIN) GOTO400
C
      DO120II=IK,50
      IKP=II
      XX(II)=XM(II)
      IF(XM(II).GE.DIS) GOTO130
  120 CONTINUE
  130 IF(IKP.LT.2) IKP=2
      IKPM=IKP-1
      XX(IKP)=DIS
C
      FTR1=ERATE(I,IX)/DIS
C
      DO300MN=FMON,NMON
      FTR3=SQRT(2.0/3.14159)*COVER(MN)
      LAMDA=FLAMDA(I.IX.MN)
C
      DO300N=1,NSC
      J=JSTB(N)
      IF(J.GT.6) J=6
      IF(SHT(I).GT.HT(J,MN)) GOTO300
C
      SIGMA=SGMA(J,DIS)
      CHEK=1.6*HT(J,MN)
      IF(SIGMA.GT.CHEK) SIGMA=CHEK
C
      FTR5=LAMDA*RNFRQ(J,L,MN)*FTR1*2.543
      FTR6=1.0-RNFRQ(J,L,MN)
      FTR7=(FTR1/SIGMA)*2.032
      WZ=(SHT(I)*0.1)**UE(J)
C
      DO200K=1,6
      IF(WNDFRQ(J,K,L,MN).LE.0.0) GOTO200
      WS=WNDSP(J,K)*WZ
      FTR4=WNDFRQ(J,K,L,MN)/WS
C
      BRIGG=BRIG(SDIA(I),SEVL(I),SGT(I),MAT(MN),WS,DIS)
C
      H=SHT(I)+BRIGG
      IF(H.GT.HT(J,MN)) H=HT(J,MN)
C
      DO140II=IK,IKPM
      HH=H-FLVEL*XM(II)/WS
      IF(HH.LT.0.0) HH=0.
      SIG=SIGTAB(J,II)
      IF(SIG.GT.CHEK) SIG=CHEK
      FAC=0.5*(HH/SIG)**2
      IF(FAC.GT.138.15) FAC=138.15
      FX(II)=(FTR3/SIG)/EXP(FAC)
  140 CONTINUE
C
      HH=H-FLVEL*DIS/WS
      IF(HH.LT.0.0) HH=0.
      FAC=0.5*(HH/SIGMA)**2
      IF(FAC.GT.138.15) FAC=138.15
      FX(IKP)=(FTR3/SIGMA)/EXP(FAC)
C
      SIMP=SIMRN(XX,FX,IKP,IP)
      FAC1=DV*SIMP/DIS
C
      QQ1=EXP(-FAC1*(DIS/WS))
      FTR2=(FTR4*FTR7*YCON)/EXP(FAC)
      DRY=QQ1*DV*FTR6*FTR2
      TDRY(M)=TDRY(M)+DRY
C
      QQ2=EXP(-(LAMDA+FAC1)*(DIS/WS))
      WET=QQ2*FTR4*FTR5*YCON
      TWET(M)=TWET(M)+WET
C
      FAC=FTR2*(FTR6*QQ1+RNFRQ(J,L,MN)*QQ2)
      CON(M)=CON(M)+FAC
  200 CONTINUE
  300 CONTINUE
  400 CONTINUE
      RETURN
      END
C****
C    FUNCTION DVEL COMPUTES THE DEPOSITION VELOCITY FOR DRYFALL
C    CALCULATIONS
C****
      FUNCTION DVEL(ITYP,DIA,DEN)
      REAL MU
      DATA G/980.0/,MU/1.827E+04/
C
C  FOR SMALL PARTICLES AND FOR GASES, SURFACE ROUGHNESS
C  ENHANCES DEPOSITION AND DVEL IS SET AT 0.01
C
      IF(ITYP.EQ.2) GOTO30
      GMU=G/(18.0*MU)
      VD=GMU*(DIA*DIA)*DEN
C  CONVERT FROM CM/SEC TO M/SEC
      VD=VD*0.01
C
      IF(VD.LT.0.01) GOTO30
      DVEL=VD
      RETURN
C
C     VD=0.0
   30 DVEL=0.01
      RETURN
      END
C****
C    FUNCTION WASH COMPUTES THE WASHOUT COEFFICIENTS FOR WETFALL
```

```
C    CALCULATIONS
C****
      FUNCTION WASH(ITYP,DIA,DEN,RBAR)
      DIMENSION A(7),B(7),ARHO(7)
      DATA A/0.0,0.09549,0.034507,0.0239916,8.11996E-03,
     19.59721E-03,0.0104141/
      DATA B/0.33333,0.8405,0.493444,0.305593,0.321280,
     10.281789,0.249265/
      DATA ARHO/4.0,7.8,16.0,41.0,81.0,169.0,400.0/
      DATA AA/5.546E-04/,PP/0.604229/
C
      IF(ITYP.EQ.2) GOTO80
C
      ITAG=0
      IKP=1
      IKPP=2
      FAC=0.
      ASR=DIA**2*DEN/4.
      IF(ARHO(1).GT.ASR) GOTO2
      GOTO3
    2 ITAG=1
      FAC=ASR/ARHO(1)
      GOTO4
    3 IF(ASR.LE.ARHO(7)) GOTO4
      ITAG=2
C
    4 IF(ITAG.NE.0) GOTO30
      DO10ITEST=2,6
      IKP=ITEST
      IF(ASR.GT.ARHO(ITEST)) GOTO20
   10 CONTINUE
C
   20 IKPP=IKP+1
      FAC=(ASR-ARHO(IKP))/(ARHO(IKPP)-ARHO(IKP))
C
   30 IF(ITAG.NE.1) GOTO40
      Y=FAC*(B(1)*RBAR)
      GOTO60
C
   40 IF(ITAG.NE.2) GOTO50
      Y=(-B(7)+SQRT(B(7)**2+4.*A(7)*RBAR))/(2.*A(7))
      GOTO60
C
   50 Y1=(-B(IKP)+SQRT(B(IKP)**2+4.*A(IKP)*RBAR))/(2.*A(IKP))
      Y2=(-B(IKPP)+SQRT(B(IKPP)**2+4.*A(IKPP)*RBAR))/(2.*A(IKPP))
      Y=Y1*(1.-FAC)+Y2*FAC
C
   60 WASH=1.0E-04*Y
      RETURN
C
   80 DEN1=DEN*100.**2
      Y=AA*RBAR**PP
      WASH=Y*DEN1
      RETURN
      END
C****
C    FUNCTION DIST COMPUTES THE RADIAL DISTANCE IN A WIND SECTOR
C    FROM SOURCE TO RECEPTOR GAUGE GIVEN RECTANGULAR (X,Y)
C    COORDINATES OF SOURCE AND RECEPTOR
```

```
C****
      FUNCTION DIST(SX,SY,RX,RY,L)
      COMMON/C3/CV
      DATA DEG/22.5/
C
      TK=DEG*(L-1)
      B=TK/57.2958
      WB=SIN(B)
      WA=COS(B)
C
      VX=SX-RX
      VY=SY-RY
      XP=(VY*WA+VX*WB)*CV
C
C  IF SOURCE MAKES NO CONTRIBUTION TO RECEPTOR, SKIP
      YP=ABS((VY*WB-VX*WA)*CV)
      TM=XP*0.19891
      IF(YP.LE.TM) GOTO40
      DIST=0.
      RETURN
C
   40 DIST=XP
      RETURN
      END
C****
C     FUNCTION SGMA COMPUTES THE VERTICAL DISPERSION COEFFICIENT
C     FOR THE GAUSSIAN PLUME ALGORITHM
C****
      FUNCTION SGMA(NTYP,DIS)
      DIMENSION AONE(6),ATWO(6),BONE(6),BTWO(6),CONE(6),
     1CTWO(6),DONE(6),DTWO(6),RGH(6)
      COMMON/C1/XM(50),SIGCOF(6,50),SIGMAX(6),KDISP,IKPM,ROUGH
      DATA AONE/0.112,0.130,0.112,0.098,0.0609,0.0638/
      DATA ATWO/5.38E-4,6.52E-4,9.05E-4,1.35E-3,1.96E-3,1.36E-3/
      DATA BONE/1.06,0.950,0.920,0.889,0.895,0.783/
      DATA BTWO/0.815,0.750,0.718,0.688,0.684,0.672/
      DATA CONE/1.56,2.02,2.72,5.16,7.37,11.7/
      DATA CTWO/6.25E-4,7.76E-4,0.,186.,4.29E+3,4.59E+4/
      DATA DONE/0.0480,0.0269,0.,-0.060,-0.0957,-0.128/
      DATA DTWO/0.45,0.37,0.,-0.225,-0.60,-0.78/
      DATA RGH/0.01,0.04,0.10,0.40,1.0,4.0/
C
      IKP=IKPM+1
      IF(KDISP.EQ.2) GOTO35
C
C  PASQUILL-GIFFORD DISPERSION VALUES
      P=ALOG(SIGCOF(NTYP,IKP)/SIGCOF(NTYP,IKPM))/ALOG(XM(IKP)/XM(IKPM))
      A=SIGCOF(NTYP,IKP)/XM(IKP)**P
      SGMA=A*DIS**P
      GOTO45
C
C  HOSKER'S FORMULATION OF BRIGGS-SMITH DISPERSION VALUES
   35 ABS=ROUGH
      C1=YLAG(ABS,RGH,CONE,0,3,6)
      C2=YLAG(ABS,RGH,CTWO,0,3,6)
      D1=YLAG(ABS,RGH,DONE,0,3,6)
      D2=YLAG(ABS,RGH,DTWO,0,3,6)
      G=AONE(NTYP)*DIS**BONE(NTYP)/(1.0+ATWO(NTYP)*DIS**BTWO(NTYP))
      F=C1*(DIS**D1)
      F=ALOG(F)
      IF(ROUGH.LE.0.10) GOTO39
      F=F+ALOG(1.+1./(C2*DIS**D2))
      GOTO43
   39 F=F-ALOG(1.+C2*DIS**D2)
   43 SGMA=G*F
      IF(SGMA.LT.1.0) SGMA=1.0
C
   45 RETURN
      END
C****
C     FUNCTION BRIG COMPUTES THE PLUME RISE DUE TO BUOYANCY FROM
C     THE SOURCE
C****
      FUNCTION BRIG(SDIA,SEVL,SGT,MAT,WS,DIS)
      REAL MAT
      DATA G/9.8/
C
      SDIB=SDIA*0.5
      F=(G*SEVL*SDIB*SDIB)*((SGT-MAT)/SGT)
      IF(F.GE.55.) GOTO21
      XX=14.*F**0.625
      GOTO23
   21 XX=34.*F**0.4
C
   23 FB=1.6*F**0.3333
      XXA=3.5*XX
      IF(DIS.LE.XXA) GOTO25
      BRIG=(FB/WS)*XXA**0.6667
      GOTO27
   25 BRIG=(FB/WS)*DIS**0.6667
C
   27 RETURN
      END
C****
C     FUNCTION SIMRN COMPUTES BY SIMPSON,S RULE THE ATTENUATION
C     OF THE SURFACE CONCENTRATIONS BY DEPOSITION
C****
      FUNCTION SIMRN(XX,FX,IKP,IP)
      DIMENSION XX(1),FX(1),AX(50)
C
      AX(IP-1)=0.0
      DO30II=IP,IKP,2
      D1=XX(II)-XX(II-1)
      IF(IKP.GT.II) GO TO 20
      AX(II)=AX(II-1)+D1/2.0*(FX(II)+FX(II-1))
      GO TO 40
   20 D2=XX(II+1)-XX(II-1)
      D3=D2/D1
      A2=(D3/6.)*D2/(1.-1./D3)
      A3=D2/2.0-A2/D3
      A1=D2-A2-A3
      AX(II+1)=AX(II-1)+A1*FX(II-1)+A2*FX(II)+A3*FX(II+1)
   30 CONTINUE
C
   40 SIMRN=AX(IKP)
C
      RETURN
      END
```

```
C****
C     FUNCTION YLAG SUPPORTS FUNCTION SGMA FOR COMPUTING VERTICAL
C     DISPERSION COEFFICIENTS
C****
      FUNCTION YLAG (XI,X,Y,IND,N,IMAX)
C
C  LAGRANGIAN INTERPOLATION
C  XI IS INTERPOLATED ENTRY INTO X-ARRAY
C  N IS THE ORDER OF LAGRANGIAN INTERPOLATION
C  Y IS ARRAY FROM WHICH YLAG IS OBTAINED BY INTERPOLATION
C  IND IS THE MIN-I FOR X(I).GT.XI
C  IF IND=0, X-ARRAY WILL BE SEARCHED
C  IMAX IS MAX INDEX OF X- AND Y-ARRAYS
C
      DIMENSION X(1),Y(1)
C
      IF(N.LE.IMAX) GOTO10
      N=IMAX
   10 IF(IND.GT.0) GOTO40
      DO20J=1,IMAX
      JJ=J
      IF(XI-X(J)) 30,130,20
   20 CONTINUE
      GOTO70
C
   30 IND=JJ
   40 IF(IND.GT.1) GOTO50
   50 INL=IND-(N+1)/2
      IF(INL.GT.0) GOTO60
      INL=1
   60 INU=INL+N-1
      IF(INU.LE.IMAX) GOTO80
C
   70 INL=IMAX-N+1
      INU=IMAX
   80 S=0.
      DO110J=INL,INU
      P=1.
      D=1.
      DO100I=INL,INU
      IF(I.EQ.J) GOTO100
      P=P*(XI-X(J))
      D=D*(X(J)-X(I))
  100 CONTINUE
  110 S=S+Y(J)*(P/D)
      YLAG=S
      RETURN
C
  130 YLAG=Y(JJ)
      RETURN
      END
/*
//LKED.SYSPRINT DD SYSOUT=1
/*
//DELETE   EXEC PGM=IEHPROGM
//SYSPRINT DD  SYSOUT=P
//SYSRES   DD  UNIT=3311,VOL=SER=SYSRES,DISP=OLD
//DD05     DD  UNIT=3311,VOL=SER=SYS306,DISP=OLD
//SYSIN    DD  DSN=CDPS.PROCLIB(HL120001),DISP=SHR
```

```
//*
//HL1226S EXEC PGM=HL1226
//STEPLIB  DD  DSN=FORTL,DISP=SHR
//SYSUDUMP DD  SYSOUT=P
//FT06F001 DD  SYSOUT=1
//FT07F001 DD  DSN=DF.HL120510,UNIT=3311,DISP=(NEW,CATLG,DELETE),
//             DCB=(BLKSIZE=1600,LRECL=80,RECFM=FB),
//             VOL=SER=SYS306,SPACE=(TRK,(60,60),RLSE)
//FT11F001 DD  DSN=HL1.MET.BISMK,DISP=OLD
//FT12F001 DD  DSN=HL1.MET.DIKSN,DISP=OLD
//FT13F001 DD  DSN=HL1.MET.MINOT,DISP=OLD
//FT14F001 DD  DSN=HL1.MET.WLSTN,DISP=OLD
//FT15F001 DD  DSN=HL1.MET.CMPST,DISP=OLD
//HL3126S.FT05F001 DD *
/*
```

Example of ATDM Output

```
ANNUAL   WET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA

THE GRID CONVERSION FACTOR (CV): 1609.8

DRY DEPOSITION PARAMETERS:

THE SLOPING PLUME OPTION FOR PARTICLES (TILT):  1

             SURFACE
   PERIOD     COVER
     JAN       1.
     FEB       1.
     MAR       1.
     APR       2.
     MAY       2.
     JUN       3.
     JUL       3.
     AUG       3.
     SEP       3.
     OCT       3.
     NOV       2.
     DEC       2.


WET DEPOSITION PARAMETERS:

             AVERAGE RAINFALL   FRACTION OF TIME
   PERIOD     RATE (IN/HR)        RAIN OCCURS
     JAN         0.090               0.023
     FEB         0.100               0.032
     MAR         0.110               0.044
     APR         0.130               0.053
     MAY         0.160               0.055
     JUN         0.210               0.054
     JUL         0.190               0.028
     AUG         0.190               0.027
     SEP         0.140               0.031
     OCT         0.110               0.026
     NOV         0.090               0.015
     DEC         0.090               0.018

THE NUMBER OF STABILITY CLASSES AND STABILITIES USED:  6; 1. 2. 3. 4. 5. 6

THE NUMBER OF WIND DIRECTIONS AND DIRECTIONS USED: 16; 1. 2. 3. 4. 5. 6. 7. 8.
                                                       9.10.11.12.13.14.15.16
```

```
ANNUAL   MET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA

THE DISPERSION COEFFICIENTS OPTION (KDISP):  2

THE EFFECTIVE SURFACE ROUGHNESS (ROUGH): 0.10

DISTANCE                          VERTICAL DISPERSION COEFFICIENTS (METERS)
  (M)          SC1            SC2            SC3            SC4            SC5            SC6

      1.   0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01
      2.   0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01
      3.   0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01
      4.   0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01
      5.   0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01
     10.   0.12822E 01    0.11551E 01    0.10000E 01    0.10000E 01    0.10000E 01    0.10000E 01
     15.   0.19660E 01    0.16957E 01    0.13451E 01    0.10796E 01    0.10000E 01    0.10000E 01
     20.   0.26663E 01    0.22260E 01    0.17501E 01    0.13917E 01    0.10000E 01    0.10000E 01
     25.   0.33736E 01    0.27486E 01    0.21461E 01    0.16941E 01    0.10676E 01    0.10000E 01
     30.   0.40881E 01    0.32649E 01    0.25348E 01    0.19869E 01    0.12540E 01    0.10000E 01
     35.   0.48083E 01    0.37760E 01    0.29175E 01    0.22775E 01    0.14363E 01    0.10179E 01
     40.   0.55332E 01    0.42625E 01    0.32951E 01    0.25608E 01    0.16153E 01    0.11295E 01
     45.   0.62622E 01    0.47849E 01    0.36681E 01    0.28395E 01    0.17913E 01    0.12359E 01
     50.   0.69947E 01    0.52838E 01    0.40371E 01    0.31140E 01    0.19646E 01    0.13405E 01
    150.   0.22004E 02    0.14775E 02    0.10899E 02    0.80911E 01    0.50938E 01    0.31058E 01
    200.   0.29607E 02    0.19293E 02    0.14098E 02    0.10357E 02    0.65091E 01    0.38593E 01
    300.   0.44823E 02    0.28024E 02    0.20205E 02    0.14620E 02    0.91563E 01    0.52266E 01
    400.   0.59961E 02    0.36438E 02    0.26019E 02    0.18620E 02    0.11622E 02    0.64655E 01
    500.   0.74970E 02    0.44595E 02    0.31605E 02    0.22420E 02    0.13948E 02    0.76126E 01
    600.   0.89624E 02    0.52532E 02    0.37000E 02    0.26057E 02    0.16161E 02    0.86867E 01
    700.   0.10451E 03    0.60275E 02    0.42232E 02    0.29556E 02    0.18278E 02    0.97069E 01
    800.   0.11902E 03    0.67845E 02    0.47320E 02    0.32936E 02    0.20311E 02    0.10677E 02
    900.   0.13336E 03    0.75257E 02    0.52279E 02    0.36210E 02    0.22271E 02    0.11605E 02
   1000.   0.14751E 03    0.82523E 02    0.57120E 02    0.39389E 02    0.24166E 02    0.12496E 02
   1100.   0.16150E 03    0.89654E 02    0.61855E 02    0.42483E 02    0.26001E 02    0.13355E 02
   1200.   0.17530E 03    0.96657E 02    0.66489E 02    0.45498E 02    0.27761E 02    0.14185E 02
   1300.   0.18894E 03    0.10354E 03    0.71032E 02    0.48440E 02    0.29512E 02    0.14988E 02
   1400.   0.20241E 03    0.11031E 03    0.75487E 02    0.51315E 02    0.31197E 02    0.15768E 02
   1600.   0.22865E 03    0.12355E 03    0.84160E 02    0.56882E 02    0.34440E 02    0.17262E 02
   1800.   0.25466E 03    0.13639E 03    0.92541E 02    0.62227E 02    0.37534E 02    0.18680E 02
   2000.   0.27986E 03    0.14888E 03    0.10066E 03    0.67376E 02    0.40494E 02    0.20032E 02
   2500.   0.34037E 03    0.17872E 03    0.11995E 03    0.79504E 02    0.47398E 02    0.23169E 02
   3000.   0.39763E 03    0.20684E 03    0.13801E 03    0.90739E 02    0.53712E 02    0.26022E 02
   3500.   0.45197E 03    0.23348E 03    0.15502E 03    0.10124E 03    0.59546E 02    0.28647E 02
   4000.   0.50368E 03    0.25882E 03    0.17114E 03    0.11111E 03    0.64978E 02    0.31085E 02
   4500.   0.55300E 03    0.28301E 03    0.18647E 03    0.12044E 03    0.70067E 02    0.33363E 02
   5000.   0.60015E 03    0.30616E 03    0.20110E 03    0.12929E 03    0.74859E 02    0.35504E 02
   6000.   0.68865E 03    0.34974E 03    0.22853E 03    0.14578E 03    0.83691E 02    0.39442E 02
   7000.   0.77043E 03    0.39016E 03    0.25389E 03    0.16090E 03    0.91693E 02    0.43000E 02
   8000.   0.84645E 03    0.42795E 03    0.27751E 03    0.17490E 03    0.99021E 02    0.46251E 02
  10000.   0.98411E 03    0.49683E 03    0.32044E 03    0.20014E 03    0.11207E 03    0.52023E 02
  15000.   0.12671E 04    0.64045E 03    0.40958E 03    0.25192E 03    0.13829E 03    0.63528E 02
  20000.   0.14915E 04    0.75630E 03    0.48132E 03    0.29313E 03    0.15871E 03    0.72392E 02
  30000.   0.18372E 04    0.93743E 03    0.59350E 03    0.35702E 03    0.18982E 03    0.85660E 02
  40000.   0.21007E 04    0.10770E 04    0.68012E 03    0.40606E 03    0.21339E 03    0.95469E 02
  50000.   0.23142E 04    0.11907E 04    0.75084E 03    0.44599E 03    0.23244E 03    0.10322E 03
  60000.   0.24942E 04    0.12866E 04    0.81069E 03    0.47974E 03    0.24847E 03    0.10961E 03
  70000.   0.26502E 04    0.13696E 04    0.86260E 03    0.50900E 03    0.26235E 03    0.11502E 03
  80000.   0.27880E 04    0.14428E 04    0.90848E 03    0.53485E 03    0.27461E 03    0.11972E 03
 100000.   0.30241E 04    0.15676E 04    0.98690E 03    0.57906E 03    0.29556E 03    0.12755E 03
```

ANNUAL   MET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA

MIXING HEIGHTS (METERS)

PERIOD	SC 1	SC 2	SC 3	SC 4	SC 5	SC 6
JAN	0.	293.	354.	390.	431.	429.
FEB	0.	418.	501.	504.	592.	600.
MAR	486.	924.	936.	885.	961.	1166.
APR	1113.	1835.	1749.	1437.	1733.	1932.
MAY	1518.	1655.	1554.	1409.	1723.	1973.
JUN	1889.	1675.	1549.	1330.	1530.	1822.
JUL	1773.	1727.	1582.	1440.	1631.	1664.
AUG	1840.	1925.	1630.	1525.	1615.	1880.
SEP	2184.	1616.	1295.	1116.	1318.	1519.
OCT	1023.	1194.	1082.	1014.	1203.	1342.
NOV	0.	523.	629.	621.	751.	753.
DEC	0.	335.	293.	350.	392.	382.

PERIOD	MEAN ATMOSPHERIC TEMPERATURE (K)
JAN	261.7
FEB	262.8
MAR	269.3
APR	279.2
MAY	285.7
JUN	290.9
JUL	294.5
AUG	293.4
SEP	287.5
OCT	281.3
NOV	271.4
DEC	264.0

CENTRAL WIND SPEEDS (M/SEC)

WIND SPEED CLASS	STABILITY CLASS					
	SC 1	SC 2	SC 3	SC 4	SC 5	SC 6
1	0.80	0.95	0.95	0.95	0.90	0.85
2	2.25	2.55	2.55	2.55	2.50	2.50
3	0.0	3.95	4.23	4.48	4.15	4.05
4	0.0	0.0	6.85	6.75	6.85	5.90
5	0.0	0.0	9.50	9.40	9.20	0.0
6	0.0	0.0	12.10	12.30	0.0	0.0

```
ANNUAL   NET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA


TIME PERIOD: JAN

SECTOR    WSC 1               WSC 2               WSC 3               WSC 4               WSC 5               WSC 6
                                        THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  1

  1       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  2       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  3       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  4       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  5       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  6       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  7       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  8       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  9       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 10       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 11       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 12       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 13       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 14       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 15       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 16       0.0                 0.0                 0.0                 0.0                 0.0                 0.0
                                        THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  2

  1       0.536666E-04        0.0                 0.0                 0.0                 0.0                 0.0
  2       0.263333E-04        0.0                 0.0                 0.0                 0.0                 0.0
  3       0.496666E-04        0.0                 0.0                 0.0                 0.0                 0.0
  4       0.481667E-04        0.0                 0.0                 0.0                 0.0                 0.0
  5       0.624167E-04        0.0                 0.0                 0.0                 0.0                 0.0
  6       0.477500E-04        0.0                 0.0                 0.0                 0.0                 0.0
  7       0.565000E-04        0.0                 0.0                 0.0                 0.0                 0.0
  8       0.290833E-04        0.0                 0.0                 0.0                 0.0                 0.0
  9       0.576666E-04        0.0                 0.0                 0.0                 0.0                 0.0
 10       0.317500E-04        0.0                 0.0                 0.0                 0.0                 0.0
 11       0.104917E-03        0.0                 0.0                 0.0                 0.0                 0.0
 12       0.446667E-04        0.0                 0.0                 0.0                 0.0                 0.0
 13       0.109333E-03        0.0                 0.0                 0.0                 0.0                 0.0
 14       0.466667E-04        0.0                 0.0                 0.0                 0.0                 0.0
 15       0.415000E-04        0.0                 0.0                 0.0                 0.0                 0.0
 16       0.117500E-04        0.0                 0.0                 0.0                 0.0                 0.0
                                        THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  3

  1       0.620833E-04        0.109333E-03        0.446667E-04        0.0                 0.0                 0.0
  2       0.425000E-04        0.102417E-03        0.445833E-04        0.0                 0.0                 0.0
  3       0.619167E-04        0.118083E-03        0.208333E-04        0.0                 0.0                 0.0
  4       0.469167E-04        0.152000E-03        0.253333E-04        0.0                 0.0                 0.0
  5       0.100583E-03        0.176083E-03        0.260833E-04        0.0                 0.0                 0.0
  6       0.440000E-04        0.135083E-03        0.492500E-04        0.0                 0.0                 0.0
  7       0.835833E-04        0.193250E-03        0.702500E-04        0.0                 0.0                 0.0
  8       0.424167E-04        0.144500E-03        0.813333E-04        0.0                 0.0                 0.0
  9       0.111417E-03        0.247500E-03        0.783333E-04        0.0                 0.0                 0.0
 10       0.569166E-04        0.221500E-03        0.112583E-03        0.0                 0.0                 0.0
 11       0.938333E-04        0.428833E-03        0.149583E-03        0.0                 0.0                 0.0
 12       0.698333E-04        0.252083E-03        0.196167E-03        0.0                 0.0                 0.0
 13       0.831667E-04        0.267416E-03        0.210250E-03        0.0                 0.0                 0.0
 14       0.390833E-04        0.175667E-03        0.178333E-03        0.0                 0.0                 0.0
 15       0.416666E-04        0.128333E-03        0.132500E-03        0.0                 0.0                 0.0
 16       0.260833E-04        0.620833E-04        0.772500E-04        0.0                 0.0                 0.0
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ANNUAL   MET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA


TIME PERIOD: JAN

SECTOR    WSC 1                 WSC 2                 WSC 3                 WSC 4                 WSC 5                 WSC 6
                                          THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  4
   1      0.201167E-03          0.353666E-03          0.894000E-03          0.102608E-02          0.343916E-03          0.918333E-04
   2      0.107833E-03          0.228750E-03          0.672166E-03          0.532417E-03          0.170500E-03          0.501667E-04
   3      0.206917E-03          0.378083E-03          0.603250E-03          0.306083E-03          0.479167E-04          0.122500E-04
   4      0.992500E-04          0.273667E-03          0.744500E-03          0.400583E-03          0.611666E-04          0.281666E-04
   5      0.149583E-03          0.390916E-03          0.104675E-02          0.735083E-03          0.142750E-03          0.157500E-04
   6      0.100833E-03          0.265750E-03          0.792750E-03          0.675333E-03          0.169583E-03          0.284166E-04
   7      0.184083E-03          0.397333E-03          0.106350E-02          0.720416E-03          0.153250E-03          0.255000E-04
   8      0.103667E-03          0.226083E-03          0.877083E-03          0.954833E-03          0.256333E-03          0.913333E-04
   9      0.150250E-03          0.256417E-03          0.759916E-03          0.742333E-03          0.235583E-03          0.610833E-04
  10      0.618333E-04          0.217833E-03          0.684666E-03          0.655583E-03          0.234417E-03          0.595833E-04
  11      0.141917E-03          0.230667E-03          0.799000E-03          0.933083E-03          0.255083E-03          0.200000E-04
  12      0.555000E-04          0.233167E-03          0.100042E-02          0.201308E-02          0.676333E-03          0.145167E-03
  13      0.118750E-03          0.222417E-03          0.117950E-02          0.359100E-02          0.113033E-02          0.295667E-03
  14      0.110750E-03          0.240500E-03          0.125083E-02          0.391558E-02          0.234817E-02          0.820750E-03
  15      0.129500E-03          0.301917E-03          0.135883E-02          0.295908E-02          0.190433E-02          0.902666E-03
  16      0.638333E-04          0.268667E-03          0.954916E-03          0.190250E-02          0.115817E-02          0.539250E-03
                                          THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  5
   1      0.0                   0.157417E-03          0.102167E-03          0.0                   0.0                   0.0
   2      0.0                   0.122500E-03          0.705000E-04          0.0                   0.0                   0.0
   3      0.0                   0.192250E-03          0.531667E-04          0.0                   0.0                   0.0
   4      0.0                   0.232917E-03          0.195667E-03          0.0                   0.0                   0.0
   5      0.0                   0.306667E-03          0.195500E-03          0.0                   0.0                   0.0
   6      0.0                   0.289417E-03          0.187667E-03          0.0                   0.0                   0.0
   7      0.0                   0.312916E-03          0.196917E-03          0.0                   0.0                   0.0
   8      0.0                   0.261167E-03          0.199333E-03          0.0                   0.0                   0.0
   9      0.0                   0.393250E-03          0.324416E-03          0.0                   0.0                   0.0
  10      0.0                   0.251583E-03          0.306417E-03          0.0                   0.0                   0.0
  11      0.0                   0.457500E-03          0.662500E-03          0.0                   0.0                   0.0
  12      0.0                   0.320417E-03          0.894167E-03          0.0                   0.0                   0.0
  13      0.0                   0.339166E-03          0.123808E-02          0.0                   0.0                   0.0
  14      0.0                   0.202167E-03          0.929167E-03          0.0                   0.0                   0.0
  15      0.0                   0.244000E-03          0.513750E-03          0.0                   0.0                   0.0
  16      0.0                   0.131500E-03          0.195500E-03          0.0                   0.0                   0.0
                                          THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  6
   1      0.351416E-03          0.143250E-03          0.0                   0.0                   0.0                   0.0
   2      0.180917E-03          0.142667E-03          0.0                   0.0                   0.0                   0.0
   3      0.299083E-03          0.155583E-03          0.0                   0.0                   0.0                   0.0
   4      0.293833E-03          0.241750E-03          0.0                   0.0                   0.0                   0.0
   5      0.462833E-03          0.310667E-03          0.0                   0.0                   0.0                   0.0
   6      0.321666E-03          0.230667E-03          0.0                   0.0                   0.0                   0.0
   7      0.466666E-03          0.263583E-03          0.0                   0.0                   0.0                   0.0
   8      0.287917E-03          0.228417E-03          0.0                   0.0                   0.0                   0.0
   9      0.507416E-03          0.409000E-03          0.0                   0.0                   0.0                   0.0
  10      0.305166E-03          0.352917E-03          0.0                   0.0                   0.0                   0.0
  11      0.595167E-03          0.592750E-03          0.0                   0.0                   0.0                   0.0
  12      0.501833E-03          0.548083E-03          0.0                   0.0                   0.0                   0.0
  13      0.534333E-03          0.591416E-03          0.0                   0.0                   0.0                   0.0
  14      0.301750E-03          0.412750E-03          0.0                   0.0                   0.0                   0.0
  15      0.318250E-03          0.265333E-03          0.0                   0.0                   0.0                   0.0
  16      0.143250E-03          0.139000E-03          0.0                   0.0                   0.0                   0.0

THE SUM OF ALL OF THE ABOVE JOINT WIND FREQUENCIES IS: 0.083328
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Joint Wind Frequency Data
For the Months of
February Through November
Not Shown, Output Format
Is as Shown for January
or December

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ANNUAL   NET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA

TIME PERIOD: DEC

SECTOR   WSC 1               WSC 2               WSC 3               WSC 4               WSC 5               WSC 6
                                THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  1
  1      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  2      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  3      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  4      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  5      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  6      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  7      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  8      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
  9      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 10      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 11      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 12      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 13      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 14      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 15      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
 16      0.0                 0.0                 0.0                 0.0                 0.0                 0.0
                                THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  2
  1      0.154167E-04        0.0                 0.0                 0.0                 0.0                 0.0
  2      0.215833E-04        0.0                 0.0                 0.0                 0.0                 0.0
  3      0.364166E-04        0.0                 0.0                 0.0                 0.0                 0.0
  4      0.420000E-04        0.0                 0.0                 0.0                 0.0                 0.0
  5      0.385000E-04        0.0                 0.0                 0.0                 0.0                 0.0
  6      0.470833E-04        0.0                 0.0                 0.0                 0.0                 0.0
  7      0.853333E-04        0.0                 0.0                 0.0                 0.0                 0.0
  8      0.236667E-04        0.0                 0.0                 0.0                 0.0                 0.0
  9      0.503333E-04        0.0                 0.0                 0.0                 0.0                 0.0
 10      0.422500E-04        0.0                 0.0                 0.0                 0.0                 0.0
 11      0.100000E-03        0.0                 0.0                 0.0                 0.0                 0.0
 12      0.510833E-04        0.0                 0.0                 0.0                 0.0                 0.0
 13      0.946666E-04        0.0                 0.0                 0.0                 0.0                 0.0
 14      0.374167E-04        0.0                 0.0                 0.0                 0.0                 0.0
 15      0.220000E-04        0.0                 0.0                 0.0                 0.0                 0.0
 16      0.205000E-04        0.0                 0.0                 0.0                 0.0                 0.0
                                THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  3
  1      0.478333E-04        0.910833E-04        0.411666E-04        0.0                 0.0                 0.0
  2      0.206666E-04        0.970000E-04        0.213333E-04        0.0                 0.0                 0.0
  3      0.551667E-04        0.129167E-03        0.150000E-04        0.0                 0.0                 0.0
  4      0.451667E-04        0.119333E-03        0.408333E-04        0.0                 0.0                 0.0
  5      0.929167E-04        0.142167E-03        0.316667E-04        0.0                 0.0                 0.0
  6      0.572500E-04        0.147250E-03        0.454167E-04        0.0                 0.0                 0.0
  7      0.945000E-04        0.199750E-03        0.851667E-04        0.0                 0.0                 0.0
  8      0.445833E-04        0.198250E-03        0.938333E-04        0.0                 0.0                 0.0
  9      0.106083E-03        0.294833E-03        0.103833E-03        0.0                 0.0                 0.0
 10      0.425000E-04        0.264000E-03        0.144583E-03        0.0                 0.0                 0.0
 11      0.150083E-03        0.434417E-03        0.198583E-03        0.0                 0.0                 0.0
 12      0.849167E-04        0.263250E-03        0.230583E-03        0.0                 0.0                 0.0
 13      0.976333E-04        0.255000E-03        0.272833E-03        0.0                 0.0                 0.0
 14      0.456333E-04        0.159333E-03        0.180250E-03        0.0                 0.0                 0.0
 15      0.327500E-04        0.121917E-03        0.164000E-03        0.0                 0.0                 0.0
 16      0.184167E-04        0.610833E-04        0.545000E-04        0.0                 0.0                 0.0
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ANNUAL   MET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA


TIME PERIOD: DEC

SECTOR       WSC 1               WSC 2               WSC 3               WSC 4               WSC 5               WSC 6
                                       THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  4

   1         0.143667E-03        0.287083E-03        0.795333E-03        0.598750E-03        0.145667E-03        0.316667E-04
   2         0.971666E-04        0.234833E-03        0.593333E-03        0.393583E-03        0.905833E-04        0.966667E-05
   3         0.154667E-03        0.310500E-03        0.565083E-03        0.326333E-03        0.264166E-04        0.133333E-05
   4         0.113167E-03        0.283583E-03        0.801583E-03        0.445167E-03        0.437500E-04        0.105833E-04
   5         0.235750E-03        0.453666E-03        0.107583E-02        0.702000E-03        0.743333E-04        0.126667E-04
   6         0.122917E-03        0.295500E-03        0.101442E-02        0.803500E-03        0.123750E-03        0.368333E-04
   7         0.262633E-03        0.414583E-03        0.111617E-02        0.974916E-03        0.200417E-03        0.370833E-04
   8         0.111917E-03        0.310583E-03        0.991083E-03        0.101608E-02        0.327416E-03        0.569166E-04
   9         0.176633E-03        0.350417E-03        0.987250E-03        0.930833E-03        0.159833E-03        0.307500E-04
  10         0.102833E-03        0.248500E-03        0.874750E-03        0.846833E-03        0.208083E-03        0.465000E-04
  11         0.135667E-03        0.355667E-03        0.985000E-03        0.103733E-02        0.234833E-03        0.156667E-04
  12         0.660000E-04        0.256917E-03        0.115733E-02        0.201417E-02        0.475500E-03        0.576666E-04
  13         0.165750E-03        0.301333E-03        0.128492E-02        0.315175E-02        0.834916E-03        0.230333E-03
  14         0.115083E-03        0.246083E-03        0.139192E-02        0.405450E-02        0.223125E-02        0.106200E-02
  15         0.144250E-03        0.336833E-03        0.121133E-02        0.274933E-02        0.182958E-02        0.103742E-02
  16         0.837500E-04        0.219083E-03        0.806333E-03        0.129850E-02        0.723083E-03        0.271833E-03
                                       THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  5

   1         0.0                 0.192917E-03        0.114333E-03        0.0                 0.0                 0.0
   2         0.0                 0.146917E-03        0.653333E-04        0.0                 0.0                 0.0
   3         0.0                 0.152083E-03        0.429167E-04        0.0                 0.0                 0.0
   4         0.0                 0.227667E-03        0.130333E-03        0.0                 0.0                 0.0
   5         0.0                 0.330000E-03        0.135167E-03        0.0                 0.0                 0.0
   6         0.0                 0.236750E-03        0.147917E-03        0.0                 0.0                 0.0
   7         0.0                 0.355166E-03        0.195167E-03        0.0                 0.0                 0.0
   8         0.0                 0.323917E-03        0.253583E-03        0.0                 0.0                 0.0
   9         0.0                 0.420667E-03        0.385750E-03        0.0                 0.0                 0.0
  10         0.0                 0.273333E-03        0.380000E-03        0.0                 0.0                 0.0
  11         0.0                 0.425000E-03        0.716083E-03        0.0                 0.0                 0.0
  12         0.0                 0.319917E-03        0.104525E-02        0.0                 0.0                 0.0
  13         0.0                 0.306583E-03        0.138342E-02        0.0                 0.0                 0.0
  14         0.0                 0.195667E-03        0.989500E-03        0.0                 0.0                 0.0
  15         0.0                 0.190833E-03        0.487500E-03        0.0                 0.0                 0.0
  16         0.0                 0.121333E-03        0.190333E-03        0.0                 0.0                 0.0
                                       THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS  6

   1         0.237583E-03        0.181917E-03        0.0                 0.0                 0.0                 0.0
   2         0.126333E-03        0.997500E-04        0.0                 0.0                 0.0                 0.0
   3         0.248417E-03        0.131417E-03        0.0                 0.0                 0.0                 0.0
   4         0.278667E-03        0.248750E-03        0.0                 0.0                 0.0                 0.0
   5         0.454583E-03        0.258250E-03        0.0                 0.0                 0.0                 0.0
   6         0.319666E-03        0.210500E-03        0.0                 0.0                 0.0                 0.0
   7         0.527166E-03        0.267333E-03        0.0                 0.0                 0.0                 0.0
   8         0.225417E-03        0.268333E-03        0.0                 0.0                 0.0                 0.0
   9         0.558583E-03        0.487083E-03        0.0                 0.0                 0.0                 0.0
  10         0.288583E-03        0.413000E-03        0.0                 0.0                 0.0                 0.0
  11         0.668083E-03        0.697500E-03        0.0                 0.0                 0.0                 0.0
  12         0.447083E-03        0.594500E-03        0.0                 0.0                 0.0                 0.0
  13         0.699250E-03        0.623750E-03        0.0                 0.0                 0.0                 0.0
  14         0.344250E-03        0.388917E-03        0.0                 0.0                 0.0                 0.0
  15         0.315250E-03        0.251667E-03        0.0                 0.0                 0.0                 0.0
  16         0.165000E-03        0.119333E-03        0.0                 0.0                 0.0                 0.0

THE SUM OF ALL OF THE ABOVE JOINT WIND FREQUENCIES IS: 0.083328
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ANNUAL   MET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA

THE POINT SOURCE EMISSION PARAMETERS:
     LOCATION     --------------- STACK ---------------
                  HEIGHT   DIAMETER   GAS VEL   GAS TEMP
   X        Y        M         M       M/SEC     DEG K
                                                              --------- POLLUTANT --------
                                                              TYPE    DIAM     DEN      RATE
                                                                        U    G/M**3    G/SEC
HESKET#1 --------
 15.70 -13.70      92.        2.1      15.8      447.
                                                                1      5.0      2.8  0.219E-03
HESKET#2 --------
 15.70 -13.70      92.        3.7      12.7      427.
                                                                1      5.0      2.8  0.478E-03
    UPA --------
 -5.40  15.10      78.        4.6      27.4      460.
                                                                1      5.0      2.8  0.204E-02
BASIN #1 --------
 -4.90  14.80     107.        5.3      16.7      451.
                                                                1      5.0      2.8  0.694E-02
BASIN #2 --------
 -4.90  14.80     152.        6.7      28.1      477.
                                                                1      5.0      2.8  0.147E-01
BEULAH#1 --------
-25.80  13.60      23.        1.5       9.4      478.
                                                                1      5.0      2.8  0.145E-02
BEULAH#2 --------
-25.80  13.60      31.        2.3      14.5      528.
                                                                1      5.0      2.8  0.102E-03
MNKOTA#1 --------
  0.10  -0.10      92.        5.8      21.3      450.
                                                                1      5.0      2.8  0.682E-02
MNKOTA#2 --------
  0.10  -0.10     168.        7.6      20.3      422.
                                                                1      5.0      2.8  0.123E-01
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         ANNUAL   MET INPUT---ALL FACILITY INFLUENCE ON THE STUDY AREA

RECEPTOR LOCATION    POLLUTANT       DRYDEP        WETDEP       TOTAL DEP       CONC
   X        Y                    UG/M**2/SEC   UG/M**2/SEC   UG/M**2/SEC    UG/M**3

  2.10    -1.02         1         0.386E-06     0.217E-05     0.256E-05     0.393E-04
  2.02    -0.67         1         0.350E-06     0.248E-05     0.283E-05     0.356E-04
  2.02     0.0          1         0.308E-06     0.250E-05     0.281E-05     0.312E-04
  2.05     0.95         1         0.289E-06     0.150E-05     0.179E-05     0.293E-04
  1.05     0.95         1         0.241E-06     0.296E-05     0.320E-05     0.244E-04
  0.95     1.95         1         0.289E-06     0.124E-05     0.153E-05     0.293E-04
 -0.95     2.05         1         0.365E-06     0.161E-05     0.197E-05     0.372E-04
  0.67    -0.05         1         0.181E-06     0.113E-04     0.115E-04     0.182E-04
  8.57    -5.67         1         0.439E-06     0.218E-06     0.657E-06     0.444E-04
  8.00    -4.62         1         0.467E-06     0.260E-06     0.727E-06     0.474E-04
  7.19    -3.95         1         0.493E-06     0.317E-06     0.810E-06     0.500E-04
 -0.67    -0.02         1         0.190E-06     0.651E-05     0.670E-05     0.191E-04
 -1.10    -2.95         1         0.262E-06     0.665E-06     0.926E-06     0.266E-04
  0.14    -2.95         1         0.287E-06     0.101E-05     0.130E-05     0.292E-04
  6.81    -2.67         1         0.585E-06     0.399E-06     0.984E-06     0.594E-04
  4.00    -4.05         1         0.530E-06     0.537E-06     0.107E-05     0.539E-04
  2.95    -2.48         1         0.520E-06     0.994E-06     0.151E-05     0.530E-04
  2.29    -2.29         1         0.479E-06     0.128E-05     0.176E-05     0.489E-04
  1.90    -1.90         1         0.417E-06     0.168E-05     0.210E-05     0.425E-04
  1.10    -2.07         1         0.283E-06     0.142E-05     0.170E-05     0.288E-04
  1.05    -1.07         1         0.224E-06     0.382E-05     0.404E-05     0.227E-04
  1.33    -0.45         1         0.220E-06     0.437E-05     0.459E-05     0.223E-04
  0.57     0.48         1         0.189E-06     0.669E-05     0.688E-05     0.191E-04
 -1.10    -0.50         1         0.202E-06     0.266E-05     0.287E-05     0.204E-04
 -1.05    -1.07         1         0.207E-06     0.207E-05     0.228E-05     0.210E-04
 -1.05    -1.95         1         0.229E-06     0.112E-05     0.135E-05     0.232E-04
 -3.00     0.05         1         0.312E-06     0.978E-06     0.129E-05     0.316E-04
 -3.05    -0.95         1         0.270E-06     0.709E-06     0.979E-06     0.274E-04
 -2.95    -2.76         1         0.263E-06     0.455E-06     0.717E-06     0.266E-04
 -4.05     1.62         1         0.384E-06     0.562E-06     0.946E-06     0.390E-04
 -2.86     1.19         1         0.342E-06     0.901E-06     0.124E-05     0.347E-04
  0.14    -2.00         1         0.229E-06     0.184E-05     0.207E-05     0.232E-04
  0.10    -1.33         1         0.190E-06     0.331E-05     0.350E-05     0.191E-04
 -0.57    -1.29         1         0.191E-06     0.205E-05     0.225E-05     0.193E-04
 -1.24    -0.10         1         0.217E-06     0.325E-05     0.346E-05     0.220E-04
```

APPENDIX D

LISTING OF ELEMENT CONCENTRATIONS:

AEROSOL
WATER
SNOW
SOIL
VEGETATION

LISTINGS OF ADDITIONAL DATA:

SAMPLING PLOT LOCATIONS
SAMPLING PLOT SOIL CHARACTERISTICS
STREAMFLOW RUNOFF

Aerosol Section

AEROSOL DATA

SITE NUMBER	SAMPLING DATE	WIND DIRECTION	FILTER WEIGHT (UG) F	FILTER WEIGHT (UG) C	SAMPLE TIME (MIN)	AVERAGE FLOW (L/MIN)
A1	629	X	418	813	1422	22.0
A4	629	X	295	481	1405	28.9
A4	705	U	372	740	1441	29.4
A1	710	D	335	625	1376	28.3
A1	711	D	316	282	1416	28.3
A4	711	D	354	438	1415	23.2
A1	712	U	418	458	1463	28.3
A3	712	D	650	822	1464	28.3
A4	712	U	298	454	1465	27.7
A2	715	X	361	650	1434	18.1
A3	715	X	285	570	1434	13.9
A2	716	U	412	571	1453	25.5
A3	716	U	397	543	1473	24.0
A1	718	U	360	530	1452	24.0
A3	718	D	223	247	1463	25.5
A2	725	D	388	411	1441	23.2
A2	730	D	101	218	1513	28.3
A2	804	D	187	322	1436	27.5
A4	804	U	358	930	1439	28.8
A3	812	X	433	755	1445	24.0
A2	814	D	434	665	1432	21.2
A1	815	U	414	430	1442	29.2
A2	815	D	314	342	1443	26.9
A3	815	D	312	353	1440	26.9
A2	819	D	367	680	1438	26.9
A1	822	X	464	985	1433	28.3
A2	822	X	350	464	1438	26.3
A3	822	X	291	485	1438	24.6
A2	824	U	366	520	1452	25.5
A3	824	U	371	484	1453	21.2
A4	824	D	345	760	1448	30.3
A2	827	D	307	361	1303	29.7
A4	827	U	362	665	1316	29.7
A2	831	U	367	461	1441	22.0
A3	831	U	294	473	1442	24.0
A4	831	D	457	884	1441	24.6
A1	901	X	471	836	1460	29.7
A2	901	X	393	423	1461	26.9
A3	901	X	356	539	1462	24.6
A2	905	X	623	718	1439	19.8
A2	907	U	541	822	1441	24.9
A3	907	U	453	790	1443	22.0
A2	909	U	531	637	1433	21.8
A3	909	U	487	654	1431	23.2
A2	916	D	256	197	1493	25.7

AEROSOL DATA

SITE NUMBER	SAMPLING DATE	WIND DIRECTION	FILTER WEIGHT (UG)		SAMPLE TIME (MIN)	AVERAGE FLOW (L/MIN)
			F	C		
A4	916	U	507	702	1490	30.8
A1	921	D	144	732	1450	28.6
A3	921	U	105	126	1449	27.1
A1	924	D	277	561	1436	27.7
A3	924	U	194	283	1432	28.6
A1	929	U	393	683	1568	21.0
A3	929	D	300	386	1567	24.6
A1	1005	X	247	275	1455	30.2
A2	1005	X	570	273	1452	29.1
A3	1005	X	210	174	1457	29.1
A4	1005	X	332	407	1456	30.5
A1	1019	X	350	783	1438	29.7
A2	1019	X	242	196	1438	26.9
A3	1019	X	206	195	1443	25.5
A4	1019	X	440	513	1440	22.9

F - FINE (0.4) FILTER. C - COARSE (12.) FILTER

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAMS/FILTER)			
		AL F / C	AS F / C	BA F / C	BR F / C
A1	629	9.1/23.5	<0.04/<0.00	<0.90/<0.86	0.13/
A4	629	5.6/13.1	<0.03/<0.00	<0.89/<0.85	0.17/
A4	705	8.7/17.4	<0.03/<0.00	<1.18/<0.83	0.18/
A1	710	7.9/30.0	<0.03/<0.00	<0.89/<0.81	0.31/
A1	711	5.6/ 1.5	<0.03/<0.02	<0.00/<0.00	0.17/
A4	711	7.8/17.3	<0.03/<0.02	<0.90/<0.00	0.15/
A1	712	11.9/17.1	<0.03/<0.02	<0.90/<0.00	0.24/
A3	712	14.4/22.0	<0.03/<0.02	<0.90/<0.00	0.23/
A4	712	5.6/16.8	<0.03/<0.03	<0.90/<0.00	0.15/
A2	715	14.3/33.1	<0.03/<0.03	<0.90/<0.95	0.12/
A3	715	11.4/ 2.9	<0.00/<0.00	<0.95/<0.00	0.12/
A2	716	14.8/22.5	<0.00/<0.00	<1.15/<0.91	0.22/
A3	716	14.8/25.1	<0.00/<0.00	<0.89/<0.91	0.20/
A1	718	18.0/28.8	<0.03/<0.00	<0.91/<0.91	0.11/
A3	718	18.6/10.7	0.04/<0.00	<0.89/<1.32	0.30/
A2	725	9.7/18.4	0.08/<0.02	<0.89/<1.94	0.11/
A2	730	2.4/ 8.6	0.05/<0.02	<0.91/<0.81	0.06/
A2	804	6.6/12.1	<0.03/<0.02	<0.98/<1.79	0.08/
A4	804	16.9/30.2	0.05/<0.02	<1.31/<0.81	0.18/
A3	812	18.1/29.6	<0.00/<0.00	<2.11/<2.70	0.18/
A2	814	14.2/27.0	<0.00/<0.00	<0.90/<0.85	0.16/
A1	815	9.2/20.5	<0.03/<0.00	<0.90/<0.76	0.12/
A2	815	4.1/12.9	<0.03/<0.00	<1.10/<1.20	0.11/
A3	815	5.8/12.0	<0.03/<0.00	<0.89/<0.71	0.21/
A2	819	16.7/62.0	<0.03/<0.02	<1.29/<2.70	0.11/
A1	822	14.2/31.2	<0.00/<0.00	<1.86/<1.14	0.15/
A2	822	10.2/23.6	<0.00/<0.00	<0.95/<0.75	0.15/
A3	822	8.6/21.0	<0.00/<0.00	<0.98/<0.77	0.17/
A2	824	4.0/24.8	<0.03/<0.02	<2.37/<0.99	0.17/
A3	824	7.0/40.0	<0.03/<0.03	<0.91/<1.09	0.17/
A4	824	6.3/36.0	<0.03/<0.03	<1.03/<0.94	0.17/
A2	827	4.6/15.9	<0.03/<0.00	<0.92/<0.00	0.15/
A4	827	6.6/33.0	<0.03/<0.00	<0.92/<0.78	0.16/
A2	831	9.1/19.8	0.06/<0.00	<0.91/<0.78	0.17/
A3	831	6.2/22.6	0.05/<0.00	<0.92/<0.78	0.15/
A4	831	10.9/26.5	0.04/<0.03	<0.92/<0.79	0.22/
A1	901	12.3/32.1	<0.04/<0.00	<2.17/<0.77	0.23/
A2	901	11.5/38.0	<0.03/<0.00	<2.19/<0.92	0.19/
A3	901	8.6/16.2	0.04/<0.00	<1.74/<1.07	0.16/
A2	905	22.3/17.0	0.11/<0.00	<2.53/<1.89	0.28/
A2	907	19.5/35.0	0.08/<0.03	<0.92/<1.14	0.20/
A3	907	13.2/33.4	<0.03/<0.03	<0.92/<0.78	0.17/
A2	909	17.8/27.9	0.04/<0.00	<0.92/<0.90	0.18/
A3	909	17.8/28.4	<0.03/<0.00	<1.41/<2.12	0.14/
A2	916	4.4/ 7.0	<0.03/<0.00	<0.91/<1.23	0.11/

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAMS/FILTER)			
		AL F / C	AS F / C	BA F / C	BR F / C
A4	916	15.0/36.8	0.04/<0.00	<0.91/<1.73	0.17/
A1	921	2.6/38.2	<0.03/<0.00	<0.90/<0.81	0.43/
A3	921	1.2/ 3.7	<0.03/<0.00	<0.89/<0.78	0.10/
A1	924	8.3/29.5	0.09/<0.00	<0.88/<0.76	0.33/
A3	924	4.9/12.1	0.04/<0.02	<1.41/<0.76	0.15/
A1	929	9.3/31.1	<0.03/<0.02	<0.90/<0.82	0.18/
A3	929	8.0/17.6	<0.03/<0.02	<0.90/<0.79	0.19/
A1	1005	4.7/ 8.9	0.04/<0.00	<0.89/<1.30	0.20/
A2	1005	6.2/11.6	<0.03/<0.00	<1.50/<0.75	0.14/
A3	1005	2.2/ 5.4	0.04/<0.00	<0.89/<0.88	0.13/
A4	1005	3.1/13.5	<0.03/<0.00	<1.04/<1.25	0.23/
A1	1019	10.3/33.1	<0.03/<0.00	<0.95/<0.93	0.27/
A2	1019	6.3/ 7.0	<0.03/<0.00	<0.91/<0.76	0.17/
A3	1019	5.1/ 6.9	0.03/<0.00	<0.90/<0.76	0.15/
A4	1019	14.2/14.0	0.05/<0.00	<0.90/<0.74	0.20/

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAMS/FILTER)			
		CA F / C	CD F / C	CL F / C	CR F / C
A1	629	9.45/ 38	<0.13/ 0.12	0.36/ 1.09	0.02/<0.00
A4	629	3.10/ 17	<0.20/ 0.12	0.20/ 1.40	0.03/<0.00
A4	705	7.50/ 22	<0.13/ 0.12	0.90/ 1.30	0.02/ 0.04
A1	710	8.70/ 35	<0.13/ 0.12	0.20/ 1.20	0.03/<0.02
A1	711	7.10/ 13	<0.00/ 0.11	0.60/ 2.00	0.02/ 0.02
A4	711	5.20/ 13	<0.14/ 0.12	0.50/ 0.90	0.02/<0.02
A1	712	6.80/ 12	<0.14/ 0.12	0.60/ 1.70	0.02/<0.02
A3	712	14.5/ 24	<0.14/ 0.23	1.20/ 0.90	0.05/<0.02
A4	712	3.10/ 10	<0.14/ 0.13	0.60/ 1.50	0.02/<0.02
A2	715	10.6/ 30	<0.14/ 0.17	0.40/ 1.00	0.02/ 0.10
A3	715	8.70/ 22	<0.15/ 0.00	0.50/ 1.00	0.03/ 0.14
A2	716	11.8/ 25	<0.14/ 0.13	0.70/ 0.70	0.04/<0.02
A3	716	11.4/ 21	<0.17/ 0.15	0.40/ 0.80	0.02/<0.02
A1	718	13.1/ 20	<0.13/ 0.12	0.20/ 0.90	0.02/<0.02
A3	718	6.50/7.2	<0.29/ 0.18	0.70/ 0.60	0.02/<0.00
A2	725	8.80/ 11	<0.24/ 0.12	0.46/ 0.50	0.08/<0.00
A2	730	3.40/ 13	<0.41/ 0.42	0.58/ 1.20	0.02/<0.02
A2	804	8.40/ 12	<0.13/ 0.19	0.38/ 0.80	0.04/<0.02
A4	804	23/ 47	<0.45/ 0.36	0.90/ 1.10	0.08/<0.02
A3	812	24/ 38	<0.18/ 0.17	0.70/ 0.40	0.08/<0.00
A2	814	10.2/ 31	<0.17/ 0.15	0.60/ 0.50	0.02/<0.02
A1	815	8.40/ 19	<0.13/ 0.15	0.50/ 1.20	0.02/<0.02
A2	815	5.80/ 15	<0.15/ 0.14	0.51/ 0.70	0.02/<0.02
A3	815	4.50/ 14	<0.13/ 0.11	0.60/ 1.30	0.02/<0.02
A2	819	21/ 28	<0.13/ 0.27	0.80/ 0.33	0.05/<0.02
A1	822	17.5/ 28	<0.00/ 0.15	0.50/ 0.90	0.05/<0.00
A2	822	14.2/ 24	<0.13/ 0.11	0.50/ 1.10	0.04/<0.00
A3	822	13.3/ 21	<0.13/ 0.17	1.40/ 0.70	0.02/<0.00
A2	824	6.00/ 23	<0.14/ 0.11	0.43/ 0.60	0.04/<0.02
A3	824	13.1/ 26	<0.14/<0.14	0.60/<0.00	0.02/ 0.04
A4	824	10.2/ 26	<0.14/ 0.23	0.50/ 1.00	0.02/<0.02
A2	827	5.30/ 15	<0.13/ 0.36	0.40/ 0.70	0.00/<0.00
A4	827	6.40/ 26	<0.16/ 0.11	0.50/ 0.60	0.04/ 0.04
A2	831	14/ 20	<0.18/ 0.11	0.50/ 1.10	0.07/<0.02
A3	831	10.8/ 22	<0.13/ 0.13	0.40/ 0.96	0.02/<0.02
A4	831	12.2/ 30	<0.13/ 0.33	0.20/ 1.60	0.16/ 0.19
A1	901	9.30/ 18	<0.13/ 0.16	0.40/ 1.20	0.07/<0.00
A2	901	6.70/8.7	<0.13/ 0.11	0.70/ 0.01	0.02/<0.00
A3	901	7.30/ 11	<0.13/ 0.11	0.70/ 0.80	0.02/<0.00
A2	905	26/ 32	<0.23/ 0.15	0.70/ 0.42	0.03/<0.04
A2	907	20/ 28	<0.20/ 0.29	0.50/ 1.30	0.02/<0.02
A3	907	16.5/ 28	<0.13/ 0.11	0.40/ 1.00	0.02/<0.02
A2	909	16.5/ 16	<0.13/ 0.11	0.43/ 0.70	0.03/<0.02
A3	909	20/ 20	<0.13/ 0.11	0.60/ 1.20	0.17/<0.02
A2	916	8.90/8.4	<0.13/ 0.11	0.50/ 0.40	0.02/<0.02

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAMS/FILTER)			
		CA F / C	CD F / C	CL F / C	CR F / C
A4	916	23/ 35	<0.13/ 0.13	0.70/ 0.60	0.04/ 0.02
A1	921	3.30/ 44	<0.13/ 0.12	0.50/ 1.10	0.02/ 0.02
A3	921	3.20/6.7	<0.13/ 0.12	0.44/ 0.46	0.02/<0.02
A1	924	10.7/ 23	<0.00/ 0.11	0.50/ 0.70	0.03/ 0.02
A3	924	10.3/ 11	<0.00/ 0.11	0.47/ 0.40	0.03/<0.02
A1	929	11.5/ 25	<0.00/ 0.18	0.70/ 1.00	0.02/<0.02
A3	929	8.40/ 15	<0.00/ 0.12	0.70/ 0.60	0.02/<0.02
A1	1005	3.90/7.5	<0.42/ 0.11	0.60/ 0.50	0.02/<0.02
A2	1005	7.50/ 10	<0.23/ 0.20	0.50/ 0.50	0.02/<0.02
A3	1005	3.60/ 5	<0.18/ 0.24	1.00/ 0.60	0.02/<0.02
A4	1005	3.90/ 11	<0.20/ 0.24	0.60/ 0.70	0.02/<0.02
A1	1019	12.8/ 27	<0.13/ 0.12	0.70/ 1.00	0.02/ 0.07
A2	1019	6.20/8.2	<0.15/ 0.11	0.80/ 0.50	0.02/<0.02
A3	1019	4.90/6.5	<0.13/ 0.20	0.80/ 0.40	0.02/<0.02
A4	1019	15.1/ 13	<0.27/ 0.24	0.60/ 1.10	0.04/ 0.03

AEROSOL DATA

		ELEMENT (MICROGRAM/FILTER)			
SITE NUMBER	DATE	CU F / C	FE F / C	K F / C	MG F / C
A1	629	<0.01/ 0.05	6.29/ 21	3.16/ 7.78	2.81/ 8.38
A4	629	0.02/ 0.02	3.60/ 14	2.20/ 7.30	0.90/ 4.50
A4	705	<0.02/ 0.02	4.90/ 16.1	3.30/ 9.10	2.20/ 4.80
A1	710	<0.02/ 0.05	5.60/ 22.3	2.40/ 8.10	3.00/ 9.00
A1	711	<0.00/ 0.02	4.80/ 8.30	2.50/ 3.60	3.80/ 4.60
A4	711	<0.00/ 0.02	5.00/ 9.90	2.80/ 5.00	1.80/ 6.40
A1	712	<0.02/ 0.02	7.20/ 9.80	5.30/ 6.00	3.30/ 3.80
A3	712	<0.02/ 0.02	10.1/ 14.8	6.10/ 7.20	4.00/ 5.60
A4	712	<0.02/ 0.02	3.70/ 9.20	3.30/ 4.90	1.90/ 3.30
A2	715	0.03/ 0.02	8.70/ 22.2	3.90/ 10.1	3.80/ 10
A3	715	<0.00/ 0.03	6.80/ 16.4	3.20/ 7.00	2.60/ 5.20
A2	716	0.02/ 0.02	11.2/ 19.4	4.90/ 7.70	4.50/ 6.20
A3	716	<0.02/ 0.03	11.2/ 19.1	4.80/ 7.50	4.10/ 8.00
A1	716	<0.02/ 0.02	11.7/ 16.6	4.70/ 6.20	5.00/ 7.00
A3	718	<0.00/ 0.00	6.00/ 6.50	2.90/ 3.10	3.90/ 2.50
A2	725	<0.02/ 0.02	9.40/ 11.2	4.10/ 5.10	2.70/ 5.30
A2	730	<0.02/ 0.02	2.51/ 8.80	0.93/ 3.00	0.60/ 2.40
A2	804	<0.02/ 0.02	7.30/ 10.7	2.90/ 4.40	1.60/ 3.10
A4	804	<0.02/ 0.03	19.5/ 40	6.20/ 14.4	4.70/ 10
A3	812	0.04/ 0.02	16.5/ 24.4	5.80/ 8.60	5.60/ 10
A2	814	0.02/ 0.02	8.00/ 19	4.50/ 9.00	2.50/ 11
A1	815	0.02/ 0.01	5.90/ 10.7	3.50/ 4.50	2.90/ 7.00
A2	815	0.03/ 0.02	3.70/ 7.90	2.80/ 3.70	1.40/ 4.00
A3	815	0.02/ 0.02	3.10/ 7.90	2.40/ 3.60	2.00/ 4.50
A2	819	<0.02/ 0.02	15/ 22	5.10/ 8.30	5.00/ 6.70
A1	822	<0.02/ 0.03	11.7/ 17.7	7.00/ 8.90	3.80/ 11
A2	822	<0.02/ 0.02	7.40/ 12.4	4.80/ 6.00	3.10/ 7.00
A3	822	<0.02/ 0.01	6.90/ 11	4.30/ 5.40	3.00/ 8.00
A2	824	<0.02/ 0.03	4.30/ 13.9	2.40/ 6.40	1.00/ 8.00
A3	824	<0.02/ 0.03	6.90/ 14	2.70/ 5.50	1.90/<0.00
A4	824	0.03/ 0.02	7.90/ 19.5	3.50/ 7.80	1.10/ 11
A2	827	0.04/ 0.01	4.80/ 8.90	2.60/ 4.30	0.60/ 4.70
A4	827	0.05/ 0.04	6.50/ 22.3	3.50/ 10.1	1.70/ 9.00
A2	831	0.03/ 0.03	8.80/ 11.9	4.10/ 5.80	2.10/ 6.30
A3	831	0.05/ 0.03	6.50/ 14.2	2.70/ 6.00	1.90/ 5.10
A4	831	0.04/ 0.03	9.20/ 25.1	5.00/ 12.9	2.60/ 8.00
A1	901	<0.02/ 0.02	8.90/ 16.7	5.80/ 9.50	2.70/ 8.00
A2	901	0.06/ 0.01	6.90/ 8.10	4.40/ 4.70	2.50/ 1.10
A3	901	<0.02/ 0.01	7.10/ 9.20	4.10/ 5.10	2.20/ 3.70
A2	905	0.06/ 0.03	20.1/ 23.9	8.50/ 10.2	8.00/ 4.70
A2	907	0.06/ 0.05	13.9/ 19.1	9.20/ 9.70	4.10/ 10
A3	907	0.04/ 0.05	11.7/ 18	8.00/ 9.20	3.00/ 8.70
A2	909	0.03/ 0.01	12.6/ 14	6.70/ 7.10	4.80/ 8.00
A3	909	0.03/ 0.04	14.5/ 14.5	7.10/ 6.80	4.50/ 8.00
A2	916	0.03/ 0.02	7.90/ 6.50	2.30/ 2.10	1.50/ 2.00

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAM/FILTER) CU F / C	 FE F / C	 K F / C	 MG F / C
A4	916	0.04/ 0.03	21.7/ 32	6.50/ 10.6	5.30/ 10
A1	921	<0.02/ 0.04	2.58/ 29	0.98/ 9.50	1.20/ 11
A3	921	0.02/ 0.01	1.66/ 2.90	0.62/ 0.91	<0.26/ 1.40
A1	924	0.02/ 0.03	8.10/ 17.2	3.00/ 6.30	2.20/ 8.00
A3	924	<0.02/ 0.02	7.10/ 6.50	2.60/ 2.30	1.90/ 2.60
A1	929	<0.02/ 0.02	9.10/ 20.1	6.00/ 9.30	2.60/ 6.00
A3	929	<0.02/ 0.04	6.30/ 10.1	4.50/ 4.70	2.80/ 4.60
A1	1005	<0.02/ 0.04	3.20/ 5.20	2.10/ 2.70	1.50/ 2.70
A2	1005	<0.02/ 0.05	5.10/ 7.40	2.80/ 2.70	2.40/ 3.50
A3	1005	<0.02/ 0.02	1.89/ 2.58	2.10/ 1.24	1.00/ 1.90
A4	1005	<0.02/ 0.05	2.90/ 7.60	2.60/ 3.90	0.70/ 5.00
A1	1019	<0.02/ 0.04	10.7/ 23	5.90/ 8.20	2.70/ 9.00
A2	1019	<0.02/ 0.01	5.90/ 5.90	4.90/ 2.10	1.20/ 1.60
A3	1019	<0.02/ 0.01	4.70/ 5.60	3.50/ 2.00	1.90/ 1.30
A4	1019	0.03/ 0.02	14.2/ 11.7	8.40/ 4.00	4.60/ 3.80

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAM/FILTER) MN F / C	 NA F / C	 NI F / C	 PB F / C
A1	629	.120/ .620	2.93/ 4.19	0.03/ 0.03	1.73/ 0.45
A4	629	.067/ .300	0.94/ 2.10	<0.02/ 0.30	0.94/ 0.20
A4	705	.142/ .380	1.20/ 2.40	<0.01/<0.02	0.88/ 0.37
A1	710	.142/ .610	1.60/ 4.40	0.04/ 0.02	1.90/ 0.47
A1	711	.113/ .290	1.20/ 2.10	<0.15/ 0.03	0.73/ 0.14
A4	711	.145/ .400	0.87/ 2.50	<0.02/<0.02	0.64/ 0.22
A1	712	.160/ .330	1.20/ 2.30	<0.02/<0.01	1.09/ 0.24
A3	712	.260/ .430	3.70/ 2.90	<0.02/<0.02	1.15/ 0.23
A4	712	.092/ .300	0.85/ 2.20	<0.02/<0.02	0.90/ 0.12
A2	715	.200/ .540	1.70/ 4.40	<0.02/ 0.02	0.83/ 0.19
A3	715	.260/ .350	2.90/ 2.80	<0.00/ 0.04	0.54/ 0.20
A2	716	.220/ .430	1.80/ 2.60	<0.02/ 0.03	1.23/ 0.26
A3	716	.210/ .410	1.40/ 2.90	<0.02/ 0.07	1.17/ 0.29
A1	718	.280/ .480	2.30/ 3.20	<0.02/<0.02	0.45/ 0.23
A3	718	.270/ .159	2.40/ 1.14	<0.02/ 0.02	0.17/ 0.16
A2	725	.170/ .260	0.94/ 1.90	<0.02/ 0.02	0.58/ 0.07
A2	730	.068/ .203	0.34/ 0.80	0.03/<0.02	0.28/ 0.15
A2	804	.137/ .213	0.84/ 1.50	<0.02/<0.02	0.37/ 0.12
A4	804	.390/ .610	1.50/ 2.80	<0.02/ 0.05	0.84/ 0.35
A3	812	.280/ .440	2.50/ 3.50	0.02/ 0.03	0.76/ 0.23
A2	814	.240/ .600	1.50/ 2.70	<0.02/ 0.02	0.90/ 0.34
A1	815	.162/ .350	2.80/ 2.90	0.40/<0.01	0.62/ 0.12
A2	815	.076/ .220	1.70/ 1.70	0.04/ 0.03	0.60/ 0.20
A3	815	.094/ .208	2.90/ 2.00	0.02/<0.01	0.56/ 0.15
A2	819	.340/ .400	2.10/ 2.80	0.04/ 0.03	0.63/ 0.19
A1	822	.290/ .600	1.50/ 2.50	<0.02/ 0.06	1.00/ 0.24
A2	822	.240/ .470	1.20/ 1.80	<0.02/<0.01	0.96/ 0.24
A3	822	.210/ .410	1.50/ 1.70	<0.02/ 0.02	0.72/ 0.19
A2	824	.101/ .450	1.80/ 3.10	<0.02/ 0.04	1.15/ 0.32
A3	824	.153/ .380	1.38/ 3.20	<0.02/ 0.03	1.25/ 0.23
A4	824	.142/ .550	0.98/ 2.70	<0.02/ 0.02	1.60/ 0.26
A2	827	.104/ .370	0.93/ 1.60	<0.00/ 0.03	0.98/ 0.14
A4	827	.130/ .550	1.20/ 3.10	<0.02/ 0.03	1.00/ 0.32
A2	831	.250/ .490	1.09/ 2.10	<0.02/ 0.03	0.80/ 0.21
A3	831	.196/ .490	0.62/ 2.00	<0.02/ 0.04	0.69/ 0.22
A4	831	.220/ .550	3.10/ 3.40	<0.02/ 0.10	1.43/ 0.29
A1	901	.250/ .500	3.70/ 3.20	0.02/ 0.04	1.50/ 0.24
A2	901	.250/ .119	1.50/ 0.86	<0.02/ 0.04	1.11/ 0.16
A3	901	.208/ .300	0.70/ 1.20	<0.02/ 0.03	0.88/ 0.13
A2	905	.430/ .300	5.00/ 2.30	0.05/ 0.04	1.38/ 0.36
A2	907	.420/ .620	1.90/ 2.50	0.04/ 0.02	0.88/ 0.28
A3	907	.300/ .580	1.30/ 2.40	<0.02/ 0.04	0.78/ 0.21
A2	909	.290/ .370	2.30/ 3.20	0.02/ 0.03	0.61/ 0.19
A3	909	.290/ .390	2.10/ 3.50	0.04/ 0.02	0.57/ 0.19
A2	916	.166/ .172	0.50/ 0.53	<0.02/<0.01	0.47/ 0.13

AEROSOL DATA

		ELEMENT (MICROGRAM/FILTER)			
SITE NUMBER	DATE	MN F / C	NA F / C	NI F / C	PB F / C
A4	916	.510/ .820	1.50/ 2.60	0.03/ 0.07	0.74/ 0.22
A1	921	.088/ .970	0.61/ 2.70	<0.02/ 0.07	2.30/ 0.65
A3	921	.038/ .073	0.26/ 0.41	<0.02/<0.02	0.49/ 0.17
A1	924	.220/ .610	1.10/ 2.50	0.02/ 0.02	1.33/ 0.38
A3	924	.107/ .194	0.80/ 1.60	<0.02/ 0.02	0.51/ 0.11
A1	929	.260/ .610	1.30/ 3.20	0.03/ 0.03	0.86/ 0.23
A3	929	.200/ .350	1.70/ 1.90	0.03/<0.01	0.72/ 0.18
A1	1005	.088/ .144	1.50/ 1.32	<0.02/<0.01	0.76/ 0.27
A2	1005	.088/ .162	2.30/ 1.90	<0.02/ 0.04	0.73/ 0.20
A3	1005	.048/ .082	2.40/ 1.39	<0.02/<0.01	0.44/ 0.17
A4	1005	.082/ .230	2.70/ 1.80	<0.02/ 0.03	1.50/ 0.39
A1	1019	.240/ .520	1.20/ 2.10	<0.00/ 0.07	0.90/ 0.24
A2	1019	.160/ .151	1.50/ 0.81	<0.00/ 0.03	0.53/ 0.17
A3	1019	.125/ .154	1.10/ 0.73	<0.00/ 0.01	0.46/ 0.23
A4	1019	.300/ .250	1.90/ 1.20	<0.02/ 0.04	0.70/ 0.19

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAM/FILTER) S F / C	 SE F / C	 SI F / C	 TI F / C
A1	629	39/ 6.0	0.27/ 0.12	30/ 116	0/ 1.53
A4	629	27/ 3.5	0.19/ 0.07	22/ 120	0/ 1.25
A4	705	31/ 6.5	0.17/ 0.18	27/ 154	0/ 1.40
A1	710	26/ 5.1	0.13/ 0.13	31/ 190	0/ 1.70
A1	711	19/ 3.6	0.10/ 0.06	25/ 77	0/ 0.71
A4	711	18/ 2.1	0.13/ 0.10	30/ 99	0/ 0.80
A1	712	29/ 4.2	0.08/ 0.13	48/ 98	1/ 0.91
A3	712	28/ 5.6	0.17/ 0.11	57/ 132	1/ 1.14
A4	712	22/ 2.2	0.08/ 0.08	28/ 94	0/ 0.81
A2	715	15/ 2.9	0.08/ 0.15	50/ 192	1/ 2.00
A3	715	13/ 2.1	0.04/ 0.11	38/ 152	1/ 1.35
A2	716	17/ 2.2	0.04/ 0.11	60/ 168	1/ 1.54
A3	716	14/ 1.5	0.06/ 0.15	60/ 170	1/ 1.55
A1	718	9.0/ 2.0	<0.04/ 0.11	74/ 151	1/ 1.29
A3	718	9.3/ 1.7	<0.04/ 0.06	37/ 64	1/ 0.54
A2	725	11/ 1.4	0.09/ 0.10	49/ 97	1/ 0.95
A2	730	3.7/ 0.8	<0.03/ 0.11	12/ 66	0/ 0.58
A2	804	6.0/ 0.9	<0.04/ 0.11	39/ 96	1/ 0.85
A4	804	8.0/ 2.9	0.06/ 0.15	89/ 289	1/ 2.60
A3	812	14/ 6.5	0.07/ 0.10	75/ 173	1/ 2.20
A2	814	29/ 5.1	0.13/ 0.14	51/ 194	1/ 1.60
A1	815	31/ 4.6	0.19/ 0.08	38/ 102	1/ 0.88
A2	815	31/ 3.9	0.17/ 0.09	24/ 84	0/ 0.73
A3	815	30/ 4.1	0.16/ 0.05	19/ 77	0/ 0.71
A2	819	8.8/ 3.6	0.06/ 0.08	70/ 177	1/ 1.78
A1	822	16/ 3.6	0.05/ 0.11	83/ 194	1/ 1.40
A2	822	15/ 3.3	<0.04/ 0.08	51/ 136	1/ 0.99
A3	822	14/ 2.5	0.06/ 0.10	45/ 112	1/ 0.86
A2	824	31/ 6.6	0.13/ 0.07	24/ 114	0/ 0.98
A3	824	29/ 4.6	0.10/ 0.12	29/ 105	0/ 1.08
A4	824	27/ 4.2	0.11/ 0.14	38/ 150	1/ 1.46
A2	827	29/ 2.9	0.08/ 0.06	26/ 82	0/ 0.71
A4	827	32/ 6.6	0.14/ 0.10	36/ 177	0/ 1.70
A2	831	19/ 2.9	0.10/ 0.07	48/ 104	1/ 0.81
A3	831	19/ 3.3	0.04/ 0.11	33/ 115	0/ 1.03
A4	831	32/ 8.5	0.13/ 0.12	51/ 215	1/ 2.00
A1	901	30/ 5.4	0.08/ 0.09	61/ 178	1/ 1.57
A2	901	27/ 1.9	0.13/ 0.06	50/ 98	1/ 0.74
A3	901	22/ 1.5	0.08/<0.03	48/ 99	1/ 0.77
A2	905	32/ 5.8	0.12/<0.03	114/ 211	1/ 2.00
A2	907	19/ 4.2	0.04/ 0.05	84/ 185	1/ 1.58
A3	907	18/ 2.7	<0.03/ 0.05	73/ 181	1/ 1.47
A2	909	32/ 4.0	<0.03/ 0.07	84/ 152	1/ 1.25
A3	909	28/ 3.8	<0.03/ 0.09	86/ 142	1/ 3.00
A2	916	13/ 1.0	0.05/ 0.08	26/ 23	0/ 0.44

AEROSOL DATA

		ELEMENT (MICROGRAM/FILTER)			
SITE NUMBER	DATE	S F / C	SE F / C	SI F / C	TI F / C
A4	916	17/ 2.4	0.04/ 0.08	89/ 215	0/ 2.10
A1	921	13/ 3.8	0.06/ 0.13	14/ 292	0/ 1.85
A3	921	9.0/ 0.9	<0.03/<0.03	6.4/ 19	0/ 0.24
A1	924	6.6/ 1.8	0.08/<0.00	52/ 167	1/ 1.27
A3	924	8.6/ 1.2	0.07/ 0.06	30/ 51	1/ 0.57
A1	929	19/ 3.9	0.07/ 0.06	58/ 200	1/ 3.20
A3	929	19/ 3.6	0.09/<0.03	36/ 96	0/ 0.85
A1	1005	21/ 2.0	<0.03/ 0.04	19/ 52	0/<0.48
A2	1005	26/ 5.5	0.11/ 0.09	20/ 50	1/ 0.71
A3	1005	23/ 3.0	0.08/ 0.07	8.4/ 20	0/ 0.26
A4	1005	31/ 4.3	0.10/ 0.12	16/ 62	0/ 0.62
A1	1019	9.6/ 2.8	<0.03/ 0.11	58/ 189	1/ 1.66
A2	1019	9.6/ 1.1	<0.03/ 0.07	26/ 47	0/ 0.45
A3	1019	7.1/ 0.8	<0.03/ 0.05	20/ 46	0/ 0.37
A4	1019	14/ 1.6	<0.03/ 0.06	70/ 104	1/ 0.77

AEROSOL DATA

SITE NUMBER	DATE	ELEMENT (MICROGRAM/FILTER) V F / C	ZN F / C
A1	629	0.000/ 0.050	0.13/ 0.11
A4	629	0.015/ 0.025	0.08/ 0.07
A4	705	0.023/ 0.033	0.14/ 0.08
A1	710	0.029/ 0.073	0.11/ 0.09
A1	711	0.018/ 0.010	0.15/ 0.04
A4	711	0.023/ 0.036	0.11/ 0.05
A1	712	0.025/ 0.030	0.20/ 0.07
A3	712	0.026/ 0.040	0.20/ 0.08
A4	712	0.012/ 0.027	0.17/ 0.05
A2	715	0.033/ 0.061	0.18/ 0.07
A3	715	0.024/ 0.011	0.14/ 0.04
A2	716	0.027/ 0.045	0.19/ 0.08
A3	716	0.031/ 0.043	0.20/ 0.06
A1	718	0.352/ 0.050	0.07/<0.01
A3	718	0.034/ 0.018	0.04/ 0.04
A2	725	0.013/ 0.027	0.12/ 0.06
A2	730	0.003/ 0.016	0.04/ 0.05
A2	804	0.017/ 0.027	0.03/ 0.02
A4	804	0.035/ 0.056	0.07/ 0.12
A3	812	0.033/ 0.051	0.15/ 0.14
A2	814	0.007/ 0.044	0.17/ 0.12
A1	815	0.015/ 0.038	0.15/ 0.05
A2	815	0.011/ 0.021	0.14/ 0.06
A3	815	0.010/ 0.024	0.12/ 0.07
A2	819	0.049/ 0.160	0.08/ 0.04
A1	822	0.024/ 0.060	0.07/ 0.06
A2	822	0.018/ 0.038	0.05/ 0.02
A3	822	0.017/ 0.039	0.05/<0.01
A2	824	0.009/ 0.046	0.05/ 0.02
A3	824	0.014/ 0.100	0.06/ 0.03
A4	824	0.013/ 0.061	0.12/ 0.04
A2	827	0.012/ 0.028	0.13/ 0.06
A4	827	0.014/ 0.061	0.13/ 0.13
A2	831	0.016/ 0.038	0.14/ 0.08
A3	831	0.011/ 0.040	0.13/ 0.04
A4	831	0.020/ 0.052	0.17/ 0.14
A1	901	0.023/ 0.055	0.18/ 0.10
A2	901	0.026/ 0.060	0.14/ 0.05
A3	901	0.016/ 0.027	0.10/ 0.04
A2	905	0.050/ 0.032	0.17/ 0.07
A2	907	0.032/ 0.063	0.21/ 0.08
A3	907	0.025/ 0.058	0.21/ 0.10
A2	909	0.032/ 0.047	0.10/ 0.06
A3	909	0.032/ 0.044	0.13/ 0.05
A2	916	0.011/ 0.012	0.05/<0.01

AEROSOL DATA

		ELEMENT (MICROGRAM/FILTER)	
SITE NUMBER	DATE	V F / C	ZN F / C
A4	916	0.030/ 0.067	0.10/ 0.07
A1	921	0.005/ 0.081	0.06/ 0.12
A3	921	0.002/ 0.007	<0.01/<0.02
A1	924	0.018/ 0.060	0.10/ 0.09
A3	924	0.012/ 0.025	0.11/ 0.03
A1	929	0.018/ 0.051	0.21/ 0.13
A3	929	0.017/ 0.029	0.19/ 0.07
A1	1005	0.012/ 0.019	0.21/ 0.11
A2	1005	0.015/ 0.024	0.25/ 0.11
A3	1005	0.008/ 0.010	0.20/ 0.06
A4	1005	0.007/ 0.019	0.43/ 0.12
A1	1019	0.024/ 0.059	0.12/ 0.08
A2	1019	0.018/ 0.015	0.13/ 0.02
A3	1019	0.017/ 0.012	0.10/ 0.03
A4	1019	0.033/ 0.023	0.18/ 0.08

Water Section

STREAMFLOW DATA

DATE	CENTER RAINFALL (CM)	HAGEL CREEK STREAMFLOW (CFM)	SQUARE BUTTE CREEK STREAMFLOW (CFM)
5/ 1/78	0.00	3.4	5.9
5/ 2/78	0.00	3.1	5.9
5/ 3/78	0.00	2.9	5.2
5/ 4/78	0.00	2.9	4.6
5/ 5/78	0.23	2.8	4.3
5/ 6/78	0.10	2.6	4.3
5/ 7/78	1.65	3.2	6.2
5/ 8/78	1.47	8.2	13.0
5/ 9/78	0.00	6.7	11.0
5/10/78	0.00	4.6	15.0
5/11/78	0.00	3.8	13.0
5/12/78	0.61	3.8	10.0
5/13/78	0.00	4.5	6.8
5/14/78	0.00	3.7	5.0
5/15/78	0.00	3.0	3.5
5/16/78	0.00	2.5	3.1
5/17/78	0.00	2.1	2.6
5/18/78	0.08	1.9	2.4
5/19/78	0.30	1.8	2.3
5/20/78	0.10	1.8	2.2
5/21/78	0.00	1.8	1.7
5/22/78	0.00	1.7	1.4
5/23/78	0.00	1.5	3.3
5/24/78	0.51	1.4	6.4
5/25/78	0.03	1.4	4.7
5/26/78	0.00	1.5	4.5
5/27/78	0.00	1.4	5.3
5/28/78	0.00	1.3	3.8
5/29/78	0.00	1.7	3.2
5/30/78	0.33	1.7	2.9
5/31/78	0.10	1.8	3.1
6/ 1/78	0.18	1.1	3.1
6/ 2/78	0.43	3.3	3.6
6/ 3/78	0.00	12.0	3.6
6/ 4/78	0.00	13.0	3.2
6/ 5/78	0.00	1.4	3.4
6/ 6/78	0.00	0.8	3.8
6/ 7/78	0.08	1.0	4.3
6/ 8/78	0.00	1.1	3.6
6/ 9/78	0.00	0.8	2.3
6/10/78	0.00	0.8	1.8
6/11/78	2.54	0.8	2.6
6/12/78	0.25	0.8	4.8
6/13/78	0.03	0.7	2.7
6/14/78	0.00	0.5	1.6

STREAMFLOW DATA

DATE	CENTER RAINFALL (CM)	HAGEL CREEK STREAMFLOW (CFM)	SQUARE BUTTE CREEK STREAMFLOW (CFM)
6/15/78	1.27	0.6	1.9
6/16/78	0.30	0.6	2.1
6/17/78	0.00	0.6	1.0
6/18/78	0.00	0.7	1.8
6/19/78	0.00	0.6	1.4
6/20/78	0.00	0.4	1.8
6/21/78	0.00	0.3	2.2
6/22/78	0.00	0.3	2.2
6/23/78	0.00	0.3	2.2
6/24/78	0.20	0.2	2.3
6/25/78	0.51	0.2	2.3
6/26/78	0.56	0.2	2.3
6/27/78	0.00	0.1	2.4
6/28/78	0.03	1.5	2.4
6/29/78	1.80	47.0	3.0
6/30/78	0.20	119	3.4
7/ 1/78	0.00	28.0	4.0
7/ 2/78	0.00	4.7	4.0
7/ 3/78	0.00	1.9	3.6
7/ 4/78	0.56	1.0	3.4
7/ 5/78	0.00	0.9	3.3
7/ 6/78	0.00	0.7	3.1
7/ 7/78	0.00	0.4	2.8
7/ 8/78	0.46	0.2	2.6
7/ 9/78	0.03	0.4	2.4
7/10/78	0.00	0.6	2.2
7/11/78	0.00	0.4	2.0
7/12/78	0.51	0.5	1.8
7/13/78	0.00	0.6	1.7
7/14/78	0.00	0.6	1.6
7/15/78	0.00	0.5	1.5
7/16/78	0.00	0.4	1.4
7/17/78	0.00	0.3	1.4
7/18/78	0.00	0.2	1.4
7/19/78	2.62	0.3	2.3
7/20/78	0.13	0.3	3.0
7/21/78	0.08	0.3	2.9
7/22/78	0.00	0.3	2.6
7/23/78	0.56	0.3	2.2
7/24/78	0.00	0.2	1.7
7/25/78	0.00	0.1	1.4
7/26/78	0.00	0.1	1.1
7/27/78	0.00	0.1	0.9
7/28/78	0.00	0.1	0.9
7/29/78	0.00	0.1	0.9

STREAMFLOW DATA

DATE	CENTER RAINFALL (CM)	HAGEL CREEK STREAMFLOW (CFM)	SQUARE BUTTE CREEK STREAMFLOW (CFM)
7/30/78	0.00	0.0	0.9
7/31/78	0.00	0.0	0.9
8/ 1/78	0.61	0.0	0.9
8/ 2/78	0.00	0.0	0.8
8/ 3/78	0.00	0.0	0.8
8/ 4/78	0.00	0.0	0.7
8/ 5/78	0.00	0.0	0.8
8/ 6/78	0.00	0.0	0.8
8/ 7/78	0.00	0.0	0.7
8/ 8/78	0.00	0.0	0.6
8/ 9/78	0.00	0.0	0.6
8/10/78	0.00	0.0	0.6
8/11/78	0.00	0.0	0.6
8/12/78	0.00	0.0	0.5
8/13/78	0.00	0.0	0.5
8/14/78	0.00	0.0	0.4
8/15/78	0.00	0.0	0.4
8/16/78	0.00	0.0	0.3
8/17/78	0.36	0.0	0.2
8/18/78	0.00	0.0	0.2
8/19/78	0.00	0.0	0.2
8/20/78	0.00	0.0	0.3
8/21/78	0.00	0.0	0.3
8/22/78	0.00	0.0	0.3
8/23/78	0.13	0.0	0.3
8/24/78	0.03	0.0	0.2
8/25/78	0.00	0.0	0.2
8/26/78	0.03	0.0	0.2
8/27/78	0.97	0.0	0.5
8/28/78	0.20	0.0	0.4
8/29/78	0.00	0.0	0.3
8/30/78	0.00	0.0	0.3
8/31/78	0.41	0.0	0.3
9/ 1/78	0.00	0.0	0.4
9/ 2/78	0.00	0.0	0.4
9/ 3/78	0.00	0.0	0.5
9/ 4/78	0.00	0.0	0.7
9/ 5/78	0.00	0.0	0.8
9/ 6/78	0.00	0.0	0.8
9/ 7/78	0.00	0.0	0.6
9/ 8/78	0.00	0.0	0.6
9/ 9/78	0.00	0.0	0.5
9/10/78	0.41	0.0	0.5
9/11/78	3.78	0.0	1.0
9/12/78	0.91	0.0	2.3

STREAMFLOW DATA

DATE	CENTER RAINFALL (CM)	HAGEL CREEK STREAMFLOW (CFM)	SQUARE BUTTE CREEK STREAMFLOW (CFM)
9/13/78	0.00	0.0	1.3
9/14/78	0.00	0.0	1.1
9/15/78	0.00	0.0	1.4
9/16/78	0.03	0.0	1.4
9/17/78	0.25	0.0	1.7
9/18/78	0.33	0.0	2.2
9/19/78	0.13	0.0	1.9
9/20/78	0.00	0.0	1.7
9/21/78	0.00	0.0	1.6
9/22/78	0.00	0.0	1.6
9/23/78	0.00	0.0	1.3
9/24/78	0.00	0.0	1.2
9/25/78	0.00	0.0	1.3
9/26/78	0.00	0.0	1.3
9/27/78	0.00	0.0	1.2
9/28/78	0.00	0.0	1.3
9/29/78	0.10	0.0	1.2
9/30/78	0.00	0.0	1.1

LAKE AND STREAM DATA

LOCATION NUMBER	TEMP (C)	PH	ALK *	DO **	EC ***	ELEMENT (PPB) AS	CD	CR
SAMPLING DATE = 40279								
1	0.5	6.80	340	.	750	2.0	0.51	< 0.50
2	0.5	7.09	332	.	750	2.5	0.11	< 0.50
3	5.0	7.07	272	.	1300	8.3	0.21	0.60
4	9.0	6.09	232	.	1500	4.9	0.24	0.70
5	.	.	.	.	.	.	.	.
6	7.0	7.45	236	.	1450	6.7	1.19	0.80
7	7.0	7.70	236	.	1500	4.7	0.21	0.80
8	5.0	7.85	236	.	1500	3.8	0.23	0.70
9	11.0	6.75	224	.	1500	3.7	0.30	0.80
10	0.5	7.09	252	.	640	2.2	0.30	< 0.50
11	0.5	7.20	260	.	620	2.7	0.10	< 0.50
SAMPLING DATE = 40979								
1	0.8	7.65	292	.	650	1.8	0.04	< 0.50
2	0.8	7.80	300	.	710	2.6	0.16	0.60
3	11.0	7.95	256	.	1300	4.3	0.10	0.60
4	19.0	8.05	252	.	1540	4.0	0.12	0.70
5	.	.	.	.	.	.	.	.
6	11.5	8.35	240	.	1590	4.4	0.28	0.80
7	7.0	8.55	236	.	1460	4.2	0.12	0.70
8	7.0	8.60	236	.	1440	4.1	0.11	0.90
9	18.0	8.25	236	.	1610	3.5	0.11	0.70
10	1.0	7.70	272	.	630	2.2	0.05	< 0.50
11	1.0	7.70	252	.	600	2.2	0.04	< 0.50
SAMPLING DATE = 41679								
1	1.0	8.19	136	.	400	< 1.0	< 0.04	0.50
2	1.0	7.99	192	.	400	< 1.0	< 0.04	< 0.50
3	16.0	7.50	216	.	1240	2.0	0.05	0.80
4	24.0	6.19	228	.	1360	1.8	0.05	0.80
5	.	.	.	.	.	.	.	.
6	16.0	7.95	228	.	1420	2.4	< 0.04	0.70
7	12.0	8.25	232	.	1480	1.8	< 0.04	0.80
8	13.0	8.49	232	.	1460	1.8	0.06	0.80
9	27.0	7.80	236	.	1650	2.0	< 0.04	0.70
10	1.0	7.69	124	.	300	< 1.0	< 0.04	< 0.50
11	1.0	7.60	120	.	350	< 1.0	< 0.04	< 0.50
SAMPLING DATE = 42379								
1	7.0	6.99	120	.	395	2.2	0.13	< 0.50
2	5.0	7.25	72	.	238	2.0	0.12	< 0.50
3	10.0	6.20	124	.	450	2.0	0.13	< 0.50
4	17.5	6.40	68	.	470	2.2	0.27	< 0.50
5	.	.	.	.	.	.	.	.
6	13.0	6.69	92	.	525	1.8	0.69	0.50
7	12.0	7.09	88	.	525	1.8	0.18	< 0.50
8	11.0	7.10	88	.	580	2.2	0.31	< 0.50
9	19.0	6.75	92	.	515	1.8	0.14	< 0.50
10	9.0	7.19	120	.	510	1.8	0.18	< 0.50
11	8.5	7.20	140	.	590	2.0	0.07	< 0.50
SAMPLING DATE = 52278								
1	18.0	8.88	.	7.26	1042	.	1.30	< 0.50

LAKE AND STREAM DATA

LOCATION NUMBER	TEMP (C)	PH	ALK *	DO **	EC ***	ELEMENT (PPB)		
						AS	CD	CR
2	20.0	7.95	.	6.22	960	2.0	1.30	0.70
3	26.0	7.76	.	7.00	595	2.0	0.80	0.80
4	30.0	8.88	.	7.15	535	4.0	1.60	0.70
5	28.0	8.02	.	6.90	560	4.0	0.70	0.60
6	26.0	8.88	.	7.15	560	4.0	1.50	0.70
7	26.0	8.39	.	7.10	560	4.0	0.80	0.70
8	23.0	8.39	.	7.47	550	3.0	0.70	0.80
9	32.0	8.98	.	.	580	3.0	0.50	0.80
10	19.0	8.18	.	7.76	1200	3.0	0.60	0.80
11	19.0	8.35	.	.	1240	.	0.50	0.80
SAMPLING DATE = 53078								
1	19.0	7.90	.	5.65	1057	3.0	0.40	0.50
2	19.0	8.20	.	4.92	1003	3.0	0.70	< 0.50
3	30.0	8.10	.	6.60	597	2.0	0.60	0.50
4	35.0	8.19	.	6.60	592	.	0.60	0.50
5	32.5	8.19	.	6.40	597	2.0	0.60	< 0.50
6	29.0	8.29	.	6.45	593	2.0	0.70	0.50
7	27.0	8.09	.	6.65	587	2.0	0.60	< 0.50
8	27.0	8.09	.	6.85	587	2.0	0.60	0.50
9	35.0	8.18	.	.	548	2.0	0.60	0.50
10	19.0	8.25	.	5.02	1187	2.0	0.60	0.50
11	18.0	8.30	.	6.84	1260	2.0	0.60	0.60
SAMPLING DATE = 60578								
1	19.0	7.89	392	6.40	1247	2.3	0.30	0.70
2	19.0	8.40	336	8.10	1260	2.1	0.60	1.30
3	28.0	8.19	148	7.00	727	2.9	0.70	1.00
4	34.0	7.95	188	6.90	713	2.9	0.70	1.30
5	31.5	8.00	144	6.80	703	3.6	0.80	1.30
6	27.0	8.09	148	6.95	697	2.6	0.70	1.40
7	26.0	8.09	148	6.95	683	2.6	0.80	1.30
8	25.0	8.05	152	7.50	623	2.9	0.70	1.20
9	35.0	8.05	146	.	675	2.3	0.80	1.40
10	19.0	8.25	428	7.60	1347	2.7	0.70	1.70
11	19.0	8.29	476	7.85	1385	3.1	0.60	1.70
SAMPLING DATE = 61278								
1	18.0	7.75	382	6.40	1100	1.0	0.10	0.80
2	18.0	8.25	326	6.20	1220	1.0	0.30	0.70
3	18.0	7.75	152	6.90	718	0.7	0.10	0.60
4	33.0	8.25	156	7.20	725	0.8	0.20	0.60
5	32.0	8.25	156	6.80	725	1.2	0.20	0.60
6	28.0	8.30	148	6.50	710	1.1	0.10	0.50
7	26.0	8.35	152	6.50	697	1.0	0.10	0.50
8	25.0	8.36	148	9.40	700	1.9	0.20	1.10
9	35.0	8.36	152	.	697	1.4	0.20	0.50
10	19.0	8.10	416	6.30	1133	1.9	0.10	0.50
11	18.0	8.15	440	8.30	1340	1.3	0.20	0.50
SAMPLING DATE = 61978								
1	20.0	7.50	368	6.60	.	1.2	0.10	0.60
2	20.0	8.05	344	5.40	.	1.6	0.20	0.90
3	30.0	8.09	168	6.60	.	2.8	0.10	0.50
4	35.5	8.19	160	6.60	.	3.1	0.30	0.50
5	33.5	8.30	162	6.50	.	3.0	0.10	0.50
6	31.0	8.20	172	6.50	.	2.9	0.30	0.50

LAKE AND STREAM DATA

LOCATION NUMBER	TEMP (C)	PH	ALK *	DO **	EC ***	ELEMENT (PPB) AS	ELEMENT (PPB) CD	ELEMENT (PPB) CR
7	28.0	8.29	160	7.10	.	3.1	0.10	< 0.50
8	26.5	8.20	152	6.60	.	3.0	0.10	< 0.50
9	36.0	7.95	162	.	.	2.6	0.20	< 0.50
10	21.0	8.10	424	6.70	.	2.1	0.20	< 0.50
11	21.0	8.09	468	8.70	.	1.8	0.10	< 0.50
SAMPLING DATE = 62678								
1	21.5	7.69	374	.	910	1.8	0.35	1.10
2	21.0	8.10	322	.	1200	1.8	0.55	0.70
3	25.5	8.55	168	.	770	2.3	0.18	< 0.50
4	30.5	8.59	160	.	750	2.0	0.14	< 0.50
5	29.5	8.50	162	.	750	1.0	0.22	< 0.50
6	28.0	8.88	160	.	770	1.6	0.25	< 0.50
7	27.5	8.89	162	.	750	2.0	0.26	< 0.50
8	28.0	8.89	162	.	770	< 1.0	0.22	< 0.50
10	22.0	7.99	412	.	1200	< 1.0	0.16	< 0.50
11	22.0	7.70	420	.	1300	< 1.0	0.40	< 0.50
SAMPLING DATE = 70378								
1	25.0	8.08	370	8.10	1005	1.0	0.20	0.70
2	26.0	7.90	226	7.20	780	1.6	0.19	< 0.50
3	30.5	8.60	158	8.40	800	1.8	0.22	< 0.50
4	35.5	8.89	160	7.20	785	1.8	0.20	< 0.50
5	34.8	8.70	158	7.20	785	.	.	.
6	32.0	8.79	162	7.60	775	1.7	0.18	< 0.50
7	30.5	8.78	158	8.25	770	1.5	0.16	< 0.50
8	30.0	8.78	158	8.90	800	1.7	0.19	< 0.50
9	37.0	8.88	148	.	790	1.9	0.38	< 0.50
10	26.0	7.90	360	6.30	1105	1.3	0.21	< 0.50
11	26.0	8.30	396	6.40	1165	1.2	.	.
12	28.0	7.99	148	.	1125	25	0.21	1.20
SAMPLING DATE = 71078								
1	19.0	7.80	370	5.50	960	< 1.0	0.17	< 0.50
2	19.0	7.75	274	4.00	1005	1.2	0.16	< 0.50
3	30.0	8.50	160	7.30	870	1.8	0.16	< 0.50
4	35.0	8.99	156	6.90	800	1.8	0.22	< 0.50
5	33.0	8.99	158	6.80	790	2.0	.	.
6	31.0	8.60	160	6.70	820	1.8	0.13	< 0.50
7	28.0	8.69	158	7.10	800	1.5	0.13	< 0.50
8	28.0	8.69	158	7.60	820	1.6	0.16	< 0.50
9	35.0	8.59	160	.	800	1.6	0.13	< 0.50
10	20.0	8.19	396	6.50	1400	1.4	.	.
11	20.0	8.29	406	6.40	1140	< 1.0	0.13	< 0.50
12	24.5	7.95	160	.	900	3.3	0.24	< 0.50
SAMPLING DATE = 71778								
1	24.0	8.00	370	8.00	1100	3.6	.	.
2	24.0	7.85	282	3.20	1200	3.4	0.13	< 0.50
3	30.0	8.35	166	5.90	960	3.0	0.16	< 0.50
4	38.0	8.50	162	6.40	940	2.9	0.19	< 0.50
5	37.0	8.99	164	6.10	920	2.5	0.14	< 0.50
6	34.0	8.99	160	6.25	900	2.5	0.16	< 0.50
7	31.0	8.79	164	7.20	900	2.3	0.26	< 0.50
8	30.0	8.79	160	7.55	940	2.4	0.16	< 0.50
9	39.0	8.50	160	.	940	2.4	0.42	< 0.50
10	25.0	8.09	398	5.80	1240	2.4	0.13	< 0.50

LAKE AND STREAM DATA

LOCATION NUMBER	TEMP (C)	PH	ALK *	DO **	EC ***	ELEMENT (PPB) AS	ELEMENT (PPB) CD	ELEMENT (PPB) CR
11	25.0	8.15	428	6.35	1440	2.1	0.13	< 0.50
12	29.0	7.99	166	.	960	4.2	0.12	< 0.50
SAMPLING DATE = 72478								
1	21.0	7.85	376	7.00	1040	2.7	0.23	0.70
2	23.0	7.79	322	3.60	1200	2.6	0.08	0.70
3	32.0	8.09	164	6.00	900	2.3	0.04	< 0.50
4	36.0	8.99	160	7.00	900	2.3	0.04	< 0.50
5	37.0	8.59	164	6.90	920	2.6	0.07	< 0.50
6	33.0	8.60	162	6.50	940	.	.	.
7	32.0	8.65	166	7.00	920	3.1	0.05	< 0.50
8	31.0	8.70	162	7.10	920	2.3	0.07	< 0.50
9	39.0	8.50	162	.	900	2.3	0.07	< 0.50
10	23.0	7.99	370	6.50	1120	3.2	0.09	< 0.50
11	23.0	8.18	436	7.10	1300	.	0.12	0.60
12	27.0	8.44	140	.	1140	9.7	0.08	0.80
SAMPLING DATE = 73178								
1	21.0	7.95	368	7.90	920	3.0	0.05	< 0.50
2	21.0	7.90	350	4.55	1180	3.5	0.13	< 0.50
3	29.0	7.20	174	6.20	900	.	0.20	< 0.50
4	37.0	8.45	164	7.40	880	3.8	0.08	< 0.50
5	35.0	8.50	168	6.90	880	3.2	0.09	< 0.50
6	31.0	8.55	170	6.20	860	4.0	0.08	< 0.50
7	30.0	8.45	146	6.40	900	3.5	0.08	< 0.50
8	30.0	8.60	164	7.40	840	4.0	0.06	< 0.50
9	37.0	7.90	164	.	900	3.5	0.06	< 0.50
10	21.0	8.05	390	6.70	1100	3.2	0.08	< 0.50
11	22.0	8.41	414	7.50	1140	2.8	0.11	< 0.50
12	25.0	8.00	168	.	980	5.9	0.08	0.80
SAMPLING DATE = 80778								
1	21.0	7.89	386	9.10	1000	1.6	0.08	0.50
2	22.0	7.80	386	3.20	1100	1.8	< 0.04	0.50
3	29.0	8.39	174	6.20	920	2.3	< 0.04	< 0.50
4	36.5	8.50	168	6.70	920	2.3	< 0.04	< 0.50
5	35.0	8.50	166	6.35	940	2.5	< 0.04	< 0.50
6	32.0	8.50	168	6.30	920	2.5	< 0.04	0.60
7	31.0	8.59	168	6.65	900	2.4	.	.
8	30.0	8.60	168	7.10	900	2.1	0.12	< 0.50
9	38.0	8.30	170	.	920	2.6	< 0.04	0.70
10	22.0	7.99	390	6.55	1140	1.3	< 0.04	< 0.50
11	23.0	8.19	414	6.80	1200	1.3	< 0.04	< 0.50
12	25.0	7.99	166	.	1120	8.9	0.07	0.80
SAMPLING DATE = 81478								
1	23.0	8.09	390	7.70	1120	3.9	0.12	0.60
2	23.0	8.10	386	2.60	1280	2.7	0.22	0.60
3	34.0	8.49	172	5.70	1040	3.4	0.18	< 0.50
4	38.0	8.49	170	6.00	1060	3.2	0.18	< 0.50
5	36.0	8.50	174	5.80	1060	3.0	0.17	< 0.50
6	32.0	8.99	170	5.75	960	3.3	0.17	< 0.50
7	32.0	8.55	172	6.10	1000	3.3	0.17	< 0.50
8	31.0	8.60	172	6.50	995	3.2"	0.16	0.60
9	.	.	.	.	.	.	.	.
10	23.0	8.20	410	6.10	1180	2.2	0.13	0.60
11	23.0	8.39	420	6.00	1195	2.2	0.14	0.50

LAKE AND STREAM DATA

LOCATION NUMBER	TEMP (C)	PH	ALK *	DO **	EC ***	ELEMENT (PPB)		
						AS	CD	CR
12	25.0	8.09	174	.	1140	4.9	0.13	0.70
SAMPLING DATE = 82178								
1	18.0	.	392	7.70	1040	2.6	0.04	< 0.50
2	18.0	.	382	4.60	1280	2.7	0.10	< 0.50
3	21.0	.	178	6.10	990	3.1	0.07	< 0.50
4	35.0	.	170	6.50	1005	3.0	0.07	< 0.50
5	34.0	.	174	6.50	1000	3.0	0.08	< 0.50
6	31.0	.	172	6.60	1000	3.2	.	.
7	27.0	.	172	7.40	1000	3.4	0.08	< 0.50
8	27.0	.	168	6.70	1020	3.1	0.09	< 0.50
9	36.0	.	172	.	995	3.5	0.07	< 0.50
10	19.0	.	388	7.10	1130	2.2	0.09	< 0.50
11	19.0	.	.	7.40	1145	2.2	0.10	< 0.50
12	24.0	.	174	.	1040	3.3	0.10	< 0.50
SAMPLING DATE = 82878								
1	.	8.25	424	4.50	1000	2.3	0.10	0.60
2	.	8.10	400	3.80	1240	1.9	0.17	3.60
3	.	7.95	184	6.40	980	2.5	0.16	0.60
4	.	8.50	184	6.80	980	2.9	0.14	< 0.50
5	.	8.65	184	6.60	980	2.8	0.16	< 0.50
6	.	8.35	184	6.30	970	2.9	0.15	< 0.50
7	.	8.70	190	6.50	980	2.9	0.16	< 0.50
8	.	8.65	182	7.10	960	2.8	.	.
9	.	8.50	180	.	1000	3.0	0.11	< 0.50
10	.	8.10	388	6.30	1080	1.7	0.11	< 0.50
11	.	7.95	418	6.70	1160	1.7	0.13	< 0.50
12	.	8.15	180	.	1080	6.6	0.13	0.60
SAMPLING DATE = 91178								
1	21.0	7.99	424	5.50	1140	1.4	0.06	0.90
2	21.0	8.19	416	3.50	1320	1.6	0.12	0.80
3	29.0	8.39	188	5.70	1170	2.1	0.07	0.50
4	36.5	8.50	184	6.00	1080	2.4	0.09	0.50
5	35.0	8.59	184	6.30	1080	2.3	0.10	0.60
6	33.0	8.59	220	5.60	1080	2.4	0.09	0.60
7	30.0	8.65	190	6.00	1100	2.5	0.09	0.50
8	29.0	8.65	190	6.10	1100	2.5	0.08	0.50
9	36.0	8.29	190	.	1100	2.6	0.09	0.50
10	21.0	8.19	380	6.40	1140	1.6	0.09	0.70
11	21.0	8.19	412	5.80	1200	1.6	0.08	< 0.50
12	25.0	7.79	186	.	1100	3.3	0.09	0.60
SAMPLING DATE = 91878								
1	14.0	8.39	414	5.60	900	1.7	0.07	0.50
2	12.0	8.50	384	5.70	1340	2.0	0.15	1.20
3	22.0	8.50	194	6.80	1045	2.5	0.14	0.60
4	31.0	8.50	188	6.70	1100	2.5	0.12	0.50
5	29.0	8.50	190	6.80	1100	2.9	0.13	0.60
6	27.0	8.59	188	6.40	1060	2.4	0.14	0.50
7	24.0	8.60	190	6.10	1100	2.7	0.15	0.50
8	23.0	8.68	190	6.10	1100	2.5	0.13	0.50
9	31.0	8.50	188	.	1100	2.7	0.28	0.50
10	14.0	8.45	332	7.60	940	1.7	0.12	< 0.50
11	14.0	8.45	312	8.00	920	1.6	0.85	1.30
12	17.0	8.50	192	.	1200	4.1	0.10	0.70

LAKE AND STREAM DATA

LOCATION NUMBER	TEMP (C)	PH	ALK *	DO **	EC ***	-------ELEMENT (PPB)-------		
						AS	CD	CR
SAMPLING DATE = 92578								
1	12.0	8.20	408	8.20	1005	1.9	0.07	< 0.50
2	12.0	8.19	368	6.00	1200	2.2	0.16	< 0.50
3	22.0	8.35	196	7.00	1080	2.6	0.17	< 0.50
4	31.0	8.40	188	7.10	1130	3.1	0.16	< 0.50
5	30.0	8.45	196	6.90	1140	2.8	0.16	< 0.50
6	26.0	8.55	192	7.50	1125	3.3	0.16	< 0.50
7	24.0	8.69	196	8.20	1160	3.3	0.18	< 0.50
8	23.0	8.69	192	7.40	1140	3.2	0.16	< 0.50
9	32.0	8.25	190	.	1125	3.0	0.15	< 0.50
10	13.0	8.19	308	7.10	835	2.0	0.20	0.60
11	13.0	8.29	332	9.50	930	1.9	0.11	< 0.50
12	19.0	7.29	194	.	1150	2.7	0.17	< 0.50

* - MG/L AS CALCIUM CARBONATE. ** - MG/L. *** - MICROOHMS/CM

A . INDICATES MISSING DATA.

A < INDICATES THE CONCENTRATION WAS LESS THAN THE DETECTABLE LEVEL.

LAKE AND STREAM DATA

LOCATION NUMBER	ELEMENT (PPB)						
	CU	HG	MO	NI	PB	SE	ZN
SAMPLING DATE = 40279							
1	4.9	< 0.1	< 1.4	5.8	< 0.9	2.1	5.7
2	1.7	< 0.1	< 1.4	5.8	< 0.9	< 2.0	0.8
3	2.3	< 0.1	5.7	14.9	< 0.9	2.8	0.2
4	3.3	< 0.1	8.8	16.9	< 0.9	3.1	0.2
5	.	.	.	.	.	.	.
6	6.8	< 0.1	10.3	15.2	< 0.9	4.0	1.1
7	3.1	< 0.1	8.6	15.6	1.0	3.6	< 0.2
8	3.3	< 0.1	8.3	14.9	0.9	2.3	< 0.2
9	2.4	< 0.1	8.4	15.6	< 0.9	2.7	< 0.2
10	< 1.0	< 0.1	2.0	6.5	< 0.9	< 2.0	0.3
11	< 1.0	< 0.1	1.9	6.5	< 0.9	< 2.0	0.4
SAMPLING DATE = 40979							
1	1.4	< 0.1	4.2	4.5	< 0.9	< 2.0	0.6
2	2.6	< 0.1	< 1.4	6.5	< 0.9	< 2.0	1.7
3	4.0	< 0.1	7.5	17.5	1.2	2.3	0.4
4	4.2	< 0.1	7.9	16.9	< 0.9	2.1	0.4
5	.	.	.	.	.	.	.
6	4.5	< 0.1	8.4	19.1	< 0.9	2.3	1.5
7	4.0	0.1	7.7	17.8	< 0.9	2.8	0.4
8	5.6	< 0.1	8.1	13.6	< 0.9	2.3	0.7
9	4.2	0.1	9.3	13.6	< 0.9	2.3	0.5
10	2.2	< 0.1	2.3	4.5	< 0.9	< 2.0	0.6
11	3.0	< 0.1	1.8	4.0	< 0.9	< 2.0	0.9
SAMPLING DATE = 41679							
1	< 1.0	< 0.1	< 1.4	9.4	< 0.9	< 2.0	1.4
2	1.6	< 0.1	< 1.4	9.4	< 0.9	< 2.0	2.6
3	1.8	< 0.1	6.9	33.7	< 0.9	4.3	0.6
4	2.1	< 0.1	9.3	37.5	< 0.9	3.8	0.8
5	.	.	.	.	.	.	.
6	1.8	< 0.1	1 0.0	39.4	< 0.9	4.6	0.3
7	2.5	< 0.1	9.9	34.9	< 0.9	4.1	0.4
8	1.9	< 0.1	9.6	34.7	< 0.9	4.6	0.8
9	1.9	< 0.1	1 0.4	33.8	< 0.9	4.8	0.6
10	1.6	< 0.1	< 1.4	8.1	< 0.9	< 2.0	1.1
11	1.4	< 0.1	< 1.4	8.4	< 0.9	< 2.0	0.8
SAMPLING DATE = 42379							
1	1.5	< 0.1	< 1.4	< 4.0	< 0.9	< 2.0	1.2
2	1.7	< 0.1	< 1.4	< 4.0	< 0.9	< 2.0	1.0
3	1.6	< 0.1	2.2	< 4.0	< 0.9	< 2.0	1.0
4	2.5	< 0.1	3.0	4.4	< 0.9	< 2.0	1.0
5	.	.	.	.	.	.	.
6	4.9	< 0.1	3.0	< 4.0	< 0.9	2.0	0.8
7	2.2	< 0.1	3.0	< 4.0	< 0.9	2.0	1.0
8	3.3	< 0.1	3.1	4.6	< 0.9	2.0	1.1
9	2.2	0.1	3.2	4.4	< 0.9	< 2.0	0.8
10	2.5	< 0.1	2.4	< 4.0	< 0.9	< 2.0	0.8
11	2.0	< 0.1	2.1	4.4	< 0.9	< 2.0	0.7
SAMPLING DATE = 52278							
1	2.0	< 1.0	< 1.4	12.0	0.6	11.5	.

LAKE AND STREAM DATA

LOCATION NUMBER	CU	HG	MO	NI	PB	SE	ZN
	ELEMENT (PPB)						
2	3.4	< 1.0	< 1.4	11.0	3.4	8.5	.
3	2.8	< 1.0	< 1.4	14.0	2.6	6.1	.
4	3.4	1.3	1.5	15.0	2.9	10.2	.
5	3.5	< 1.0	< 1.4	17.0	1.7	12.4	.
6	2.9	< 1.0	1.5	12.0	6.0	14.7	.
7	2.7	< 1.0	1.6	17.0	1.8	15.1	.
8	2.9	< 1.0	4.2	19.0	2.2	14.9	.
9	2.2	< 1.0	1.8	19.0	1.8	15.2	.
10	1.6	1.2	1.7	26.0	6.0	25.7	.
11	2.0	< 1.0	2.0	22.0	4.1	34.3	.
SAMPLING DATE = 53078							
1	1.6	< 0.5	< 1.4	13.0	1.5	25.9	.
2	2.3	0.5	< 1.4	16.0	1.6	22.4	.
3	3.7	< 0.5	< 1.4	12.0	0.9	7.0	.
4	3.6	< 0.5	< 1.4	12.0	0.6	13.7	.
5	3.1	< 0.5	< 1.4	16.0	0.8	13.4	.
6	3.2	< 0.5	< 1.4	10.0	1.3	10.6	.
7	2.3	< 0.5	< 1.4	9.0	1.4	12.8	.
8	3.2	< 0.5	< 1.4	13.0	1.0	11.9	.
9	3.1	< 0.5	< 1.4	13.0	0.8	12.6	.
10	2.0	< 0.5	< 1.4	25.0	3.7	21.0	.
11	2.4	0.5	< 1.4	23.0	1.6	21.4	.
SAMPLING DATE = 60578							
1	3.4	< 0.5	< 1.4	18.0	1.3	18.6	.
2	2.9	0.5	< 1.4	19.0	1.4	16.7	.
3	3.5	< 0.5	2.1	8.0	0.6	11.0	.
4	3.0	1.8	2.1	8.0	0.9	11.0	.
5	2.8	< 0.5	2.4	8.0	0.8	10.0	.
6	2.9	0.8	4.0	9.0	1.0	8.8	.
7	3.3	1.1	4.1	11.0	1.3	10.0	.
8	2.4	0.6	4.3	8.0	1.1	9.6	.
9	2.4	2.8	4.6	7.0	0.9	7.8	.
10	1.9	< 0.5	1.6	17.0	0.8	15.3	.
11	1.6	1.3	1.6	18.0	0.8	23.2	.
SAMPLING DATE = 61278							
1	6.1	0.9	< 1.4	13.0	0.7	17.8	.
2	4.8	< 0.5	< 1.4	15.0	0.7	17.4	.
3	4.3	< 0.5	2.3	11.0	1.5	10.5	.
4	4.5	< 0.5	2.1	10.0	0.8	8.7	.
5	4.0	< 0.5	2.5	10.0	0.9	13.5	.
6	4.4	< 0.5	3.9	11.0	0.7	11.7	.
7	4.1	< 0.5	4.3	14.0	1.5	11.1	.
8	6.5	< 0.5	4.3	22.0	3.1	9.7	.
9	4.5	< 0.5	4.0	9.0	1.0	14.0	.
10	3.0	< 0.5	1.5	17.0	1.0	24.3	.
11	3.2	< 0.5	1.6	18.0	1.4	32.2	.
SAMPLING DATE = 61978							
1	1.9	< 0.5	.	8.3	1.1	27.0	14.5
2	4.3	< 0.5	.	15.2	2.3	29.6	16.0
3	3.3	0.5	.	8.3	0.8	25.5	11.5
4	4.4	< 0.5	.	8.2	0.9	24.2	19.0
5	3.9	< 0.5	.	8.4	0.9	24.8	6.0
6	4.0	< 0.5	.	8.0	0.9	20.6	13.0

LAKE AND STREAM DATA

LOCATION NUMBER	ELEMENT (PPB)						
	CU	HG	MO	NI	PB	SE	ZN
7	3.7	< 0.5	.	7.9	1.0	23.2	8.0
8	3.5	0.5	.	9.9	0.9	22.8	13.0
9	3.5	< 0.5	.	8.6	0.7	23.7	12.5
10	2.4	< 0.5	.	15.8	1.1	28.1	8.5
11	2.7	0.9	.	17.2	0.7	32.6	8.0
SAMPLING DATE = 62678							
1	2.3	< 0.5	3.1	9.9	1.3	37.2	12.0
2	6.6	< 0.5	1.5	15.5	1.8	38.9	16.5
3	4.7	< 0.5	6.4	8.5	0.9	31.2	13.0
4	4.3	< 0.5	6.5	9.1	1.0	32.4	10.5
5	5.1	< 0.5	6.9	8.9	1.0	32.0	8.5
6	5.0	< 0.5	6.6	8.8	1.0	31.2	6.5
7	4.3	< 0.5	6.4	9.1	1.0	31.1	< 2.0
8	4.2	< 0.5	6.0	8.5	1.0	32.2	< 2.0
10	3.2	< 0.5	2.1	16.6	1.7	39.6	6.0
11	4.1	< 0.5	2.3	17.6	2.2	42.9	6.0
SAMPLING DATE = 70378							
1	2.7	< 0.5	.	10.7	< 0.9	36.8	5.0
2	3.8	< 0.5	.	10.1	< 0.9	29.9	3.3
3	4.6	< 0.5	.	11.3	< 0.9	31.1	2.7
4	4.3	< 0.5	.	10.7	< 0.9	33.9	2.3
5	.	.	.	.	.	.	.
6	4.2	< 0.5	.	11.0	< 0.9	28.0	3.3
7	4.4	< 0.5	.	11.0	< 0.9	33.1	2.0
8	4.1	< 0.5	.	10.7	< 0.9	34.7	2.0
9	4.2	< 0.5	.	11.3	< 0.9	37.6	1.7
10	3.0	< 0.5	.	17.7	1.4	55.6	1.7
11	.	< 0.5	.	.	.	.	.
12	3.8	< 0.5	.	18.8	11	63.3	2.0
SAMPLING DATE = 71078							
1	3.2	< 0.5	2.2	8.9	0.9	10.0	2.7
2	2.3	< 0.5	< 1.4	11.3	0.9	7.6	3.0
3	4.7	< 0.5	7.1	8.6	0.9	7.8	2.3
4	4.4	< 0.5	7.9	8.3	< 0.9	9.7	3.3
5	.	< 0.5	.	.	.	.	.
6	3.9	< 0.5	6.9	8.4	< 0.9	4.0	< 1.3
7	4.0	< 0.5	7.3	7.8	< 0.9	5.0	9.7
8	5.9	< 0.5	7.1	8.0	< 0.9	5.6	1.7
9	4.0	< 0.5	7.5	8.1	< 0.9	6.2	2.0
10	.	< 0.5	.	.	.	.	.
11	2.9	< 0.5	2.1	11.9	< 0.9	9.2	1.3
12	4.0	< 0.5	11.7	10.3	< 0.9	8.1	2.3
SAMPLING DATE = 71778							
1	.	< 0.5	.	.	.	.	.
2	2.9	< 0.5	.	14.0	1.4	7.9	1.1
3	3.3	< 0.5	.	9.9	0.9	5.9	1.2
4	3.6	< 0.5	.	9.7	< 0.9	7.4	1.1
5	3.6	< 0.5	.	10.1	< 0.9	6.7	1.1
6	3.6	< 0.5	.	8.6	< 0.9	7.1	2.0
7	3.8	< 0.5	.	9.2	< 0.9	8.4	1.3
8	3.6	< 0.5	.	9.1	< 0.9	7.4	0.9
9	4.4	< 0.5	.	9.5	< 0.9	9.4	2.2
10	3.0	< 0.5	.	15.7	1.1	11.4	1.0

LAKE AND STREAM DATA

LOCATION NUMBER	ELEMENT (PPB)						
	CU	HG	MO	NI	PB	SE	ZN
11	3.0	< 0.5	.	14.9	1.4	13.3	0.8
12	3.9	< 0.5	.	11.4	< 0.9	8.4	2.1
SAMPLING DATE = 72478							
1	3.8	< 0.1	1.7	8.3	< 0.9	6.5	3.9
2	5.5	0.1	< 1.4	12.4	< 0.9	5.9	1.0
3	3.8	< 0.1	5.7	10.2	< 0.9	3.1	1.6
4	4.6	< 0.1	5.9	9.2	< 0.9	2.6	1.6
5	4.6	< 0.1	5.9	9.1	< 0.9	2.7	0.5
6	.	0.2	.	.	.	.	.
7	4.6	< 0.1	5.2	9.1	< 0.9	< 0.2	1.2
8	4.7	< 0.1	5.8	10.8	< 0.9	2.0	2.9
9	4.6	< 0.1	6.0	9.6	< 0.9	< 2.0	0.8
10	2.8	< 0.1	2.0	13.0	1.1	5.7	0.9
11	3.8	< 0.1	1.5	14.1	< 0.9	6.0	1.2
12	3.7	< 0.1	18.3	14.2	< 0.9	2.0	1.2
SAMPLING DATE = 73178							
1	4.5	< 0.1	.	8.6	< 0.9	3.6	1.1
2	9.6	< 0.1	.	13.1	< 0.9	5.0	1.3
3	10.7	< 0.1	.	9.6	< 0.9	3.0	1.4
4	11.0	< 0.1	.	8.8	< 0.9	3.9	1.6
5	10.5	0.1	.	8.7	< 0.9	3.9	2.1
6	9.0	0.1	.	8.1	< 0.9	3.9	0.8
7	8.0	0.1	.	9.6	< 0.9	4.7	0.8
8	8.7	0.1	.	8.3	< 0.9	4.7	0.7
9	9.7	0.2	.	7.8	< 0.9	< 2.0	2.0
10	6.5	.	.	11.3	< 0.9	7.3	0.9
11	7.5	.	.	11.8	< 0.9	8.6	1.8
12	9.5	< 0.1	.	10.8	< 0.9	3.3	1.2
SAMPLING DATE = 80778							
1	1.7	< 0.1	1.5	8.6	< 0.9	< 2.0	1.8
2	2.2	< 0.1	< 1.4	13.6	< 0.9	< 2.0	0.9
3	3.5	< 0.1	5.2	10.7	< 0.9	< 2.0	1.1
4	3.6	< 0.1	6.0	9.1	< 0.9	< 2.0	0.6
5	3.3	< 0.1	5.3	9.1	< 0.9	< 2.0	0.9
6	3.0	< 0.1	5.3	9.7	< 0.9	< 2.0	1.7
7	.	< 0.1	.	.	.	.	.
8	3.0	< 0.1	5.2	9.1	< 0.9	< 2.0	1.1
9	3.5	< 0.1	5.0	9.1	< 0.9	< 2.0	1.3
10	1.9	< 0.1	1.8	13.3	< 0.9	4.0	0.5
11	2.5	< 0.1	< 1.4	13.3	< 0.9	4.5	0.7
12	3.0	< 0.1	13.7	15.9	< 0.9	< 2.0	1.1
SAMPLING DATE = 81478							
1	4.7	< 0.1	.	8.6	< 0.9	3.9	0.9
2	3.8	0.3	.	13.1	0.9	2.7	0.9
3	4.0	0.1	.	10.5	< 0.9	< 2.0	0.6
4	4.4	0.1	.	9.5	< 0.9	2.9	1.3
5	3.9	< 0.1	.	9.7	< 0.9	< 2.0	0.9
6	4.1	< 0.1	.	8.9	< 0.9	2.4	1.2
7	4.0	0.1	.	9.7	< 0.9	< 2.0	0.7
8	3.9	0.1	.	9.7	< 0.9	< 2.0	1.0
9	.	.	.	.	.	.	.
10	2.7	0.3	.	12.9	< 0.9	< 2.0	0.7
11	3.1	0.1	.	12.6	< 0.9	< 2.0	0.6

LAKE AND STREAM DATA

LOCATION NUMBER	ELEMENT (PPB)						
	CU	HG	MO	NI	PB	SE	ZN
12	5.1	0.1	.	11.8	< 0.9	< 2.0	1.6
SAMPLING DATE = 82178							
1	2.1	< 0.1	2.2	9.5	1.4	< 2.0	1.6
2	3.1	< 0.1	1.9	14.0	1.0	2.2	4.6
3	3.4	< 0.1	6.0	10.3	< 0.9	< 2.0	1.2
4	3.4	< 0.1	6.1	9.5	< 0.9	< 2.0	1.2
5	3.6	< 0.1	6.1	10.3	< 0.9	2.1	2.4
6	.	< 0.1	.	.	.	.	.
7	3.1	< 0.1	5.7	11.9	< 0.9	< 2.0	0.6
8	3.0	< 0.1	5.8	11.9	< 0.9	< 2.0	0.8
9	3.6	< 0.1	5.9	12.0	< 0.9	< 2.0	2.1
10	2.6	< 0.1	1.7	15.2	< 0.9	< 2.0	2.5
11	3.3	< 0.1	1.7	15.9	< 0.9	< 2.0	2.2
12	4.4	< 0.1	7.4	12.5	< 0.9	2.1	1.8
SAMPLING DATE = 82878							
1	2.2	0.3	.	8.5	1.1	3.6	0.4
2	3.4	0.1	.	12.2	1.6	3.6	0.5
3	3.7	< 0.1	.	10.2	1.4	3.0	0.5
4	4.0	< 0.1	.	10.0	1.3	3.5	0.4
5	3.8	< 0.1	.	10.0	1.4	3.2	0.5
6	3.6	0.1	.	9.9	1.3	2.4	1.3
7	3.4	< 0.1	.	9.6	1.3	2.3	0.3
8	.	< 0.1	.	.	.	.	.
9	3.7	0.1	.	10.7	1.4	< 2.0	0.9
10	2.7	< 0.1	.	13.7	1.4	3.6	0.4
11	3.1	< 0.2	.	14.2	1.5	3.0	0.7
12	2.9	0.2	.	12.4	1.4	2.2	0.3
SAMPLING DATE = 91178							
1	2.5	< 0.1	1.5	8.2	0.7	6.0	0.3
2	2.9	< 0.1	1.6	12.1	0.8	8.2	0.3
3	3.1	< 0.1	5.3	10.2	0.8	5.5	0.2
4	4.0	< 0.1	5.5	10.7	0.7	6.4	0.3
5	4.1	< 0.1	7.4	10.2	0.7	6.4	0.4
6	3.7	< 0.1	6.5	10.7	0.7	7.9	0.5
7	3.2	< 0.1	5.8	10.7	0.7	6.9	0.3
8	4.4	< 0.1	5.3	11.2	0.7	3.5	1.1
9	3.7	< 0.1	5.3	9.9	0.7	5.5	0.3
10	2.2	< 0.1	< 1.4	13.0	1.3	8.7	0.2
11	2.5	< 0.1	< 1.4	13.6	0.7	7.5	0.2
12	4.1	< 0.1	7.7	12.0	0.7	6.8	0.3
SAMPLING DATE = 91878							
1	1.6	< 0.1	.	4.8	0.6	3.0	0.3
2	2.2	< 0.1	.	11.4	0.8	2.2	0.4
3	3.2	< 0.1	.	10.9	0.8	< 2.0	0.4
4	3.4	< 0.1	.	11.4	0.8	< 2.0	0.8
5	3.2	< 0.1	.	11.4	0.7	< 2.0	0.5
6	3.2	< 0.1	.	11.1	0.7	< 2.0	0.5
7	2.8	< 0.1	.	10.5	0.6	< 2.0	0.2
8	3.2	< 0.1	.	12.0	0.7	2.5	0.7
9	3.8	< 0.1	.	11.4	0.8	3.0	1.0
10	2.1	< 0.1	.	11.9	0.7	3.2	0.4
11	3.4	< 0.1	.	11.4	0.7	2.0	1.0
12	2.8	< 0.1	.	11.5	0.8	2.1	0.3

LAKE AND STREAM DATA

LOCATION NUMBER	ELEMENT (PPB)						
	CU	HG	MO	NI	PB	SE	ZN

SAMPLING DATE = 92578

1	1.6	< 0.1	< 1.4	8.0	0.8	< 2.0	0.3
2	2.8	< 0.1	2.2	13.1	1.0	< 2.0	0.3
3	3.8	< 0.1	5.8	13.2	1.0	< 2.0	0.5
4	3.8	< 0.1	5.6	12.3	1.0	< 2.0	0.4
5	4.2	< 0.1	5.5	13.5	0.9	< 2.0	0.6
6	4.3	< 0.1	5.4	13.6	0.9	< 2.0	0.6
7	4.0	< 0.1	5.7	14.0	0.9	< 2.0	0.4
8	4.0	< 0.1	5.9	14.6	0.9	< 2.0	0.3
9	4.4	< 0.1	6.7	13.5	0.9	2.0	0.5
10	3.7	< 0.1	< 1.4	12.0	1.5	< 2.0	1.2
11	2.6	< 0.1	< 1.4	13.4	0.6	< 2.0	0.3
12	3.6	< 0.1	11.4	15.3	0.8	2.0	0.4

A . INDICATES MISSING DATA.

A < INDICATES THE CONCENTRATION WAS LESS THAN THE DETECTABLE LEVEL.

Snow Section

SNOW DATA

LOCATION NUMBER	SAMPLE WEIGHT (GM)	F-	CL-	NO3-	SO4--	HG++	AS+++	SE+++
		(MICROGRAMS PER SAMPLE)						
G	773	35	200	1500	1700	< 0.4	1.5	< 1.5
60	659	32	230	1000	600	1.0	1.5	< 1.3
62	807	36	200	1200	650	< 0.4	1.7	< 1.6
47	814	200	550	1400	2500	< 0.4	1.6	< 1.6
21	949	47	330	1200	1700	< 0.5	3.5	1.9
19	837	25	240	1300	1800	< 0.4	1.8	< 1.8
18	688	55	370	1400	960	0.7	2.0	< 1.4
17	649	19	130	970	650	1.4	1.3	< 1.3
17S	927	23	180	1000	1500	< 0.5	< 1.9	< 1.9
E	527	18	130	840	1100	< 0.3	< 1.0	< 1.0
ES	957	77	120	1600	2200	< 0.5	1.9	< 1.9
43	847	25	170	1700	1100	< 0.4	< 1.2	< 1.7
A	810	36	170	1200	607	20.6	1.7	< 1.6
B	838	38	300	920	1300	< 0.4	1.9	< 1.7
C	760	19	110	1100	570	9.3	2.9	< 1.5
40	882	26	270	1200	700	< 0.4	1.8	< 1.8
D	636	19	160	890	1000	0.3	1.3	< 1.3
16	644	19	190	1000	1400	0.4	1.3	< 1.3
F	697	48	220	1400	2400	< 0.3	1.5	< 1.4

A < INDICATES THE CONCENTRATION WAS LESS THAN THE DETESTABLE LEVEL.

Field Sampling Plot Locations

X AND Y COORDINATES OF FIELD SAMPLING PLOTS

(LOCATION OF MRY FACILITY AT X=0.1, Y=-0.1)

LOCATION NUMBER	X-COOR (KM)	Y-COOR (KM)	DISTANCE (KM)	DIRECTION
1	3.4	-1.6	3.8	ESE
2	3.3	-1.1	3.4	ESE
3	3.3	0.0	3.3	E
4	3.3	1.5	3.6	ENE
5	1.7	1.5	2.3	NE
6	1.5	3.1	3.5	NNE
7	-1.5	3.3	3.6	NNW
8	1.1	-0.1	1.1	E
9	13.8	-9.1	16.5	ESE
10	12.9	-7.4	14.9	ESE
11	11.6	-6.4	13.2	ESE
12	-1.1	-0.0	1.1	W
13	-1.8	-4.7	5.1	SSW
14	0.2	-4.7	4.8	S
15	11.0	-4.3	11.8	ESE
16	6.4	-6.5	9.2	SE
17	4.7	-4.0	6.2	SE
18	3.7	-3.7	5.2	SE
19	3.1	-3.1	4.3	SE
20	1.8	-3.3	3.8	SSE
21	1.7	-1.7	2.4	SE
22	2.1	-0.7	2.3	ESE
23	0.9	0.8	1.2	
24	-1.8	-0.8	1.9	WSW
25	-1.7	-1.7	2.4	SW
26	-1.7	-3.1	3.6	SSW
27	-4.8	0.1	4.8	W
28	-4.9	-1.5	5.1	WSW
29	-4.7	-4.4	6.5	SW
30	-6.5	2.6	7.0	WNW
31	-4.6	1.9	5.0	WNW
32	0.2	-3.2	3.2	S
33	0.2	-2.1	2.1	S
34	-0.9	-2.1	2.3	SSW
35	-2.0	-0.2	2.0	W
36	-7.8	3.1	8.4	WNW
37	-8.5	-0.1	8.5	W
38	-7.5	-0.1	7.5	W
39	3.3	-7.7	8.4	SSE
40	2.9	-6.5	7.1	SSE
41	4.1	-9.5	10.3	SSE
42	6.5	-6.4	9.1	SE
43	5.3	-4.7	7.1	SE
44	6.7	-2.8	7.2	ESE
45	8.1	-3.3	8.7	ESE

X AND Y COORDINATES OF FIELD SAMPLING PLOTS

(LOCATION OF MRY FACILITY AT X=0.1, Y=-0.1)

LOCATION NUMBER	X-COOR (KM)	Y-COOR (KM)	DISTANCE (KM)	DIRECTION
46	8.7	-3.6	9.5	ESE
47	-3.4	3.4	4.8	NW
48	-4.1	10.2	11.0	NNW
49	-3.8	9.2	10.0	NNW
50	-3.4	8.2	8.9	NNW
51	-3.1	6.6	7.3	NNW
52	-2.4	5.7	6.1	NNW
53	-1.7	4.6	4.9	NNW
54	0.0	5.0	5.0	N
55	2.1	-4.8	5.2	SSE
56	-9.5	-0.1	9.5	W
57	-10	-0.1	10.4	W
58	-11	0.1	11.1	W
59	-11	3.7	11.7	WNW
60	-6.4	6.2	8.9	NW
61	-7.1	6.5	9.7	NW
62	-4.8	4.9	6.9	NW
63	0.1	-1.1	1.1	S
64	1.2	2.0	2.3	NNE

Soil Section

SURFACE 10-CM SOIL CHARACTERISTICS

Acronym	Description
SCA	Very dark brown (10YR-2/2) loam, weak to moderate coarse and medium subangular blocky structure separating into weak to moderate crumb and granular structure.
SCB	Very dark grayish brown (10YR-3/2) loam, weak to moderate coarse and medium subangular blocky structure separating into weak to moderate crumb and granular structure.
SCC	Very dark brown (10YR-2/2) silt loam, weak to moderate coarse and medium subangular blocky structure separating into weak to moderate crumb and granular structure.
SCD	Very dark brown (10YR-2/2) silty clay loam, moderate coarse and medium subangular blocky structure separating into moderate granular structure.

SCE	Very dark grayish brown (10YR-3/2) silt loam, moderate medium subangular structure separating into weak and fine platy structure.
SCF	Very dark grayish brown (10YR-3/2) loam, weak medium subangular structure separating easily into weak medium and fine platy structure.
SCG	Very dark grayish brown (10YR-3/2) fine sandy loam, weak coarse and medium subangular blocky structure separating into weak fine crumb structure.
SCH	Dark grayish brown (10YR-4/2) fine sandy loam, weak coarse and medium subangular structure separating easily into weak fine crumb structure and into a few single sand grains.

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	SOIL CLASS	PH	ELEMENT					
				CD		CR		CU	
				E	T	E	T	E	T
SAMPLING DEPTH = 1.3 CM									
1	92178	SCB	.	0.16	< 1	0.06	49	0.91	18
2	92178	SCB	.	0.13	< 1	0.05	45	0.76	17
6	92278	SCA	.	0.11	< 1	0.08	50	1.05	21
7	92278	SCA	.	0.10	< 1	0.08	60	0.87	18
8	92278	SCB	.	0.13	< 1	0.06	74	[illegible]	38
9	92178	SCB	.	0.10	< 1	0.05	51	0.68	18
10	92178	SCA	.	0.07	< 1	0.05	57	0.71	19
11	92178	SCA	.	0.16	< 1	0.07	46	0.68	17
12	92278	SCA	.	0.11	< 1	0.11	52	0.98	23
15	92178	SCA	.	0.15	< 1	0.06	38	0.69	15
21	92178	SCA	.	0.15	< 1	0.07	50	0.63	18
22	92178	SCA	.	0.13	< 1	0.07	47	0.74	15
23	92278	SCA	.	0.13	< 1	0.07	38	0.75	18
30	92178	SCA	.	0.14	< 1	0.08	45	0.64	20
31	92178	SCA	.	0.17	< 1	0.08	39	0.65	18
42	92278	SCA	.	0.14	< 1	0.09	54	1.02	22
43	92278	SCC	.	0.15	< 1	0.07	46	0.59	18
47	92278	SCB	.	0.10	< 1	0.07	28	0.52	15
55	92278	SCA	.	0.11	< 1	0.10	59	1.11	20
63	92178	SCD	.	0.13	< 1	0.09	61	0.92	33
SAMPLING DEPTH = 10. CM									
1	51078	SCB	8.0	0.07	< 1	0.04	42	1.56	21
2	51078	SCB	7.4	0.07	< 1	0.04	39	1.08	17
3	51078	SCC	7.5	0.07	< 1	0.04	38	0.91	16
4	51078	SCA	7.7	0.05	< 1	0.03	43	0.60	16
5	51078	SCA	7.4	0.08	< 1	0.04	43	0.79	21
6	51078	SCA	7.7	0.09	< 1	0.06	66	0.87	19
7	60178	SCA	7.4	0.08	< 1	0.07	49	0.99	18
8	60178	SCB	8.0	0.08	< 1	0.06	89	1.33	38
9	60278	SCB	8.2	0.09	< 1	0.05	48	0.67	19
10	60278	SCA	8.1	0.06	< 1	0.03	58	0.71	21
11	60278	SCA	6.8	0.11	< 1	0.03	43	0.55	16
12	60278	SCA	7.9	0.09	< 1	0.02	38	0.87	22
13	60278	SCA	7.5	0.12	< 1	0.03	44	0.87	20
14	60278	SCB	6.7	0.12	< 1	0.03	30	0.58	17
15	60778	SCA	7.1	0.07	< 1	0.02	25	0.48	12
16	60778	SCA	7.8	0.07	< 1	0.03	[illegible]	0.73	20
17	60778	SCC	6.8	0.11	< 1	0.03	[illegible]	0.65	15
18	60778	SCB	6.8	0.07	< 1	0.03	[illegible]	0.28	12
19	60778	SCB	8.3	0.08	< 1	0.03	53	0.53	21
20	60778	SCB	8.1	0.05	< 1	0.04	54	0.85	20

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	SOIL CLASS	PH	ELEMENT					
				CD		CR		CU	
				E	T	E	T	E	T
21	60778	SCA	8.6	0.08	< 1	0.02	31	0.43	14
22	60778	SCA	8.2	0.06	< 1	0.03	43	0.57	14
23	60778	SCA	7.4	0.10	< 1	0.03	47	0.61	16
24	60878	SCA	8.2	0.08	< 1	0.02	43	0.59	16
25	60878	SCA	7.3	0.08	< 1	0.03	46	0.40	16
26	60878	SCG	7.9	0.04	< 1	0.02	50	0.15	10
27	60878	SCA	7.6	0.09	< 1	0.03	51	0.62	20
28	60878	SCA	6.8	0.10	< 1	0.03	55	0.78	20
29	60878	SCG	8.3	0.04	< 1	0.02	46	0.40	14
30	60878	SCA	8.0	0.06	< 1	0.02	48	0.51	17
31	60878	SCA	6.7	0.09	< 1	0.03	47	0.64	17
32	60978	SCB	6.3	0.13	< 1	0.04	58	1.61	24
33	60978	SCF	6.6	0.10	< 1	0.03	50	0.81	17
34	60978	SCA	7.9	0.06	< 1	0.02	41	0.36	12
35	60978	SCA	7.0	0.13	< 1	0.03	53	0.80	22
36	60978	SCA	6.9	0.11	< 1	0.04	50	0.72	19
37	60978	SCA	7.4	0.09	< 1	0.04	51	0.69	18
38	60978	SCA	6.7	0.16	< 1	0.03	55	0.95	22
39	61378	SCA	6.3	0.16	< 1	0.04	48	0.84	19
40	61378	SCA	7.2	0.12	< 1	0.04	51	0.76	18
41	61378	SCA	7.5	0.09	< 1	0.02	49	0.70	18
42	61378	SCA	7.7	0.11	< 1	0.02	52	0.83	19
43	61378	SCC	7.8	0.08	< 1	0.02	53	0.66	18
44	61378	SCH	8.5	0.04	< 1	0.01	33	0.25	9
45	61378	SCA	7.1	0.06	< 1	0.03	46	0.54	11
46	61378	SCG	7.2	0.04	< 1	0.06	54	0.35	8
47	61478	SCB	7.2	0.07	< 1	0.03	43	0.51	14
48	61478	SCB	6.6	0.13	< 1	0.02	54	0.69	17
49	61478	SCB	8.2	0.04	< 1	0.02	49	0.27	11
50	61478	SCG	7.2	0.12	< 1	0.03	61	1.33	23
51	61478	SCB	8.1	0.07	< 1	0.03	54	0.70	17
52	61478	SCA	7.0	0.11	< 1	0.03	49	0.82	21
53	61478	SCA	8.1	0.11	< 1	0.03	52	0.89	26
54	61478	SCC	7.1	0.12	< 1	0.03	52	0.93	25
55	70678	SCA	8.0	0.03	< 1	0.03	52	0.81	18
56	70678	SCC	6.7	0.12	< 1	0.04	48	0.55	18
57	70678	SCE	6.8	0.13	< 1	0.05	47	0.65	20
58	70678	SCC	7.6	0.14	< 1	0.05	61	1.00	30
59	70678	SCA	7.4	0.11	< 1	0.02	60	1.09	29
60	70678	SCB	7.1	0.08	< 1	0.01	43	0.94	19
61	70678	SCA	7.1	0.06	< 1	0.01	48	0.54	21
62	70678	SCE	7.4	0.14	< 1	0.01	56	1.02	29
63	71278	SCD	6.9	0.15	< 1	0.08	64	1.14	36
64	71378	SCA	8.1	0.05	< 1	0.02	51	0.85	21

A . INDICATES MISSING DATA.

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	SOIL CLASS	PH	ELEMENT					
				CD		CR		CU	
				E	T	E	T	E	T

A < INDICATES THE CONCENTRATION WAS LESS THAN THE DETECTABLE LEVEL.

E - EXTRACTABLE CONCENTRATION. T - TOTAL CONCENTRATION

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT							
	MO		NI		PB		SE	
	E	T	E	T	E	T	E	T
SAMPLING DEPTH = 1.3 CM								
1	.	.	0.83	21	2.78	23	.	.
2	.	.	0.97	19	1.19	24	.	.
6	.	.	1.30	27	1.10	22	.	.
7	.	.	1.34	25	1.22	19	.	.
8	.	.	0.67	48	2.34	32	.	.
9	.	.	0.55	25	2.22	26	.	.
10	.	.	0.84	30	1.22	23	.	.
11	.	.	0.98	19	2.10	26	.	.
12	.	.	1.24	28	1.02	17	.	.
15	.	.	0.62	19	3.46	28	.	.
21	.	.	0.86	23	1.41	25	.	.
22	.	.	0.98	19	1.11	23	.	.
23	.	.	0.83	18	1.99	23	.	.
30	.	.	0.62	20	1.94	25	.	.
31	.	.	0.82	18	1.92	25	.	.
42	.	.	1.32	29	1.55	25	.	.
43	.	.	0.75	18	1.33	30	.	.
47	.	.	0.98	17	0.98	20	.	.
55	.	.	1.75	29	1.11	26	.	.
63	.	.	1.44	35	1.41	35	.	.
SAMPLING DEPTH = 10. CM								
1	0.04	< 3	1.32	20	0.74	< 10	0.008	0.72
2	0.07	< 3	1.68	17	0.57	11	0.007	0.72
3	0.07	< 3	1.49	15	0.66	13	0.005	0.58
4	0.03	< 3	0.92	22	0.57	12	0.006	0.52
5	0.07	< 3	1.43	16	1.10	11	0.008	0.75
6	0.08	< 3	1.60	24	0.78	11	0.009	0.61
7	0.04	< 3	1.41	22	0.82	12	0.008	0.53
8	0.04	< 3	0.69	51	1.30	14	0.006	0.57
9	0.04	< 3	0.55	22	1.04	12	0.011	0.51
10	0.05	< 3	0.59	26	0.96	15	0.003	0.43
11	0.07	< 3	0.98	17	0.82	< 10	0.008	0.50
12	0.06	< 3	1.16	20	0.56	< 10	0.009	0.42
13	0.06	< 3	1.35	19	0.88	10	0.010	0.71
14	0.10	< 3	1.05	12	0.94	< 10	0.009	0.70
15	0.05	< 3	0.67	9	0.73	< 10	0.004	0.36
16	0.05	< 3	1.06	27	0.77	< 10	0.013	0.64
17	0.06	< 3	1.24	17	0.81	11	0.007	0.71
18	0.04	< 3	0.28	30	0.76	< 10	0.002	0.22
19	0.03	< 3	0.90	31	0.63	< 10	0.006	0.48
20	0.04	< 3	0.75	31	0.87	< 10	0.008	0.42

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT MO E	MO T	NI E	NI T	PB E	PB T	SE E	SE T
21	0.02	< 3	0.32	18	0.82	12	0.005	0.41
22	0.04	< 3	0.83	22	0.54	14	0.008	0.42
23	0.12	< 3	0.85	20	0.93	14	0.006	0.41
24	0.07	< 3	0.65	25	0.65	12	0.005	0.32
25	0.09	< 3	0.83	24	0.72	11	0.007	0.47
26	0.03	< 3	0.50	24	0.55	12	0.004	0.33
27	0.11	< 3	0.89	25	0.70	17	0.011	0.64
28	0.14	< 3	1.57	30	0.96	15	0.012	0.75
29	0.05	< 3	0.57	27	0.54	14	0.012	0.38
30	0.05	< 3	0.56	23	0.63	< 10	0.009	0.48
31	0.07	< 3	0.94	22	0.75	< 10	0.007	0.54
32	0.12	< 3	2.72	33	1.18	13	0.005	0.64
33	0.09	< 3	1.27	25	0.91	15	0.012	0.75
34	0.06	< 3	0.66	24	0.44	11	0.007	0.40
35	0.15	< 3	1.27	35	1.27	20	0.007	0.83
36	0.11	< 3	1.28	28	1.14	16	0.006	0.48
37	0.06	< 3	1.05	31	1.04	19	0.006	0.51
38	0.14	< 3	1.28	26	1.20	20	0.003	0.74
39	0.13	< 3	1.52	23	1.32	20	0.006	0.61
40	0.12	< 3	0.98	23	1.31	23	0.011	0.69
41	0.08	< 3	0.93	28	0.88	22	0.009	0.81
42	0.08	< 3	1.03	26	0.99	19	0.013	0.79
43	0.08	< 3	1.05	25	0.71	19	0.014	0.59
44	0.02	< 3	0.20	17	0.64	13	0.007	0.40
45	0.04	< 3	0.86	26	0.74	14	0.003	0.29
46	0.03	< 3	0.98	27	0.53	12	0.001	0.21
47	0.10	< 3	0.71	22	0.76	18	0.007	0.40
48	0.09	< 3	1.09	24	1.35	18	0.004	0.54
49	0.03	< 3	0.53	31	0.43	16	0.003	0.50
50	0.09	< 3	1.37	26	1.22	25	0.005	0.65
51	0.06	< 3	0.83	24	0.74	18	0.018	0.69
52	0.10	< 3	1.21	27	1.03	23	0.008	0.50
53	0.06	< 3	0.75	29	1.41	30	0.013	0.74
54	0.11	< 3	1.47	28	1.11	26	0.007	0.90
55	0.06	< 3	0.23	33	0.62	17	0.006	0.28
56	0.10	< 3	1.09	22	0.87	18	0.006	0.60
57	0.10	< 3	1.22	23	1.15	19	0.006	0.77
58	0.10	< 3	1.30	34	1.37	25	0.007	0.82
59	0.11	< 3	1.29	33	1.16	23	0.007	0.77
60	0.34	< 3	1.11	72	1.00	16	0.004	0.55
61	0.08	< 3	1.17	22	0.82	18	0.004	0.74
62	0.13	< 3	1.17	29	1.38	23	0.006	0.52
63	0.08	< 3	1.74	40	1.41	23	0.004	0.75
64	0.07	< 3	0.98	27	0.66	17	0.007	0.44

A . INDICATES MISSING DATA.

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT							
	MO		NI		PB		SE	
	E	T	E	T	E	T	E	T

A < INDICATES THE CONCENTRATION WAS LESS THAN THE DETECTABLE LEVEL.

E – EXTRACTABLE CONCENTRATION, T – TOTAL CONCENTRATION

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT						
	S		ZN		AL	CA	FE
	E	T	E	T	T	T	T
SAMPLING DEPTH = 1.3 CM							
1	.	.	6.46	90	50200	10000	20400
2	.	.	5.32	83	51600	8700	20000
6	.	.	1.69	80	56500	18500	23400
7	.	.	2.02	74	55000	7600	24200
8	.	.	1.58	118	72900	12400	28900
9	.	.	1.95	84	55600	9200	26200
10	.	.	0.72	76	55800	11400	24500
11	.	.	5.36	95	.	8200	22800
12	.	.	1.12	81	58300	13200	25100
15	.	.	5.52	78	45900	9800	21800
21	.	.	3.92	88	51200	7600	21900
22	.	.	2.58	68	49000	7700	18600
23	.	.	3.48	76	46000	8800	19300
30	.	.	3.56	87	52300	8700	22700
31	.	.	5.76	80	47100	6800	19900
42	.	.	4.28	82	50400	7800	23100
43	.	.	3.82	84	48500	8200	20000
47	.	.	3.30	64	46000	8000	18600
55	.	.	1.27	78	50000	9900	23000
63	.	.	2.12	98	54300	8500	27800
SAMPLING DEPTH = 10. CM							
1	< 2	435	4.98	72	54900	25200	21400
2	< 2	240	8.00	74	52200	7800	20400
3	< 2	270	5.66	76	51800	8100	21000
4	< 2	270	5.40	74	56900	13000	22800
5	< 2	270	6.18	86	54800	7200	22600
6	< 2	345	6.04	78	55200	10000	22200
7	< 2	285	3.74	72	55000	8300	21900
8	< 2	345	3.30	98	68300	36700	25200
9	< 2	360	0.77	74	54600	12200	22600
10	< 2	165	0.62	76	55500	31700	24000
11	< 2	300	1.62	76	49200	7000	21800
12	< 2	255	0.63	72	56000	7600	23600
13	< 2	375	1.61	78	54500	7600	22200
14	< 2	360	2.56	67	47800	6300	19400
15	< 2	255	1.12	59	44600	6400	18300
16	< 2	300	0.51	70	.	9200	23800
17	< 2	240	5.00	76	50200	6300	19200
18	< 2	240	1.19	70	51900	5100	16800
19	< 2	345	0.63	72	53700	14000	23000
20	< 2	375	0.32	68	54800	34900	21900

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT						
	S		ZN		AL	CA	FE
	E	T	E	T	T	T	T
21	< 2	450	0.63	46	35800	64800	14700
22	< 2	300	0.63	52	41900	10800	15800
23	< 2	375	2.70	74	49200	8000	20600
24	< 2	315	1.43	66	47100	10000	21400
25	< 2	345	1.13	68	50400	7800	20500
26	< 2	225	0.39	67	55000	10400	19000
27	< 2	330	1.65	80	51400	7800	22600
28	< 2	360	3.06	84	52800	7000	22800
29	< 2	270	0.37	64	52400	15600	19400
30	< 2	240	0.76	72	50200	7400	22200
31	< 2	345	1.48	69	48700	6100	20200
32	< 2	390	2.26	88	57000	6600	25200
33	< 2	360	1.74	72	51000	7800	20200
34	< 2	240	0.47	64	51800	10200	20400
35	< 2	405	2.40	82	47300	6900	35000
36	< 2	345	2.42	75	51000	6200	23100
37	< 2	375	1.55	74	50200	7600	23600
38	< 2	435	5.82	88	49300	6200	23300
39	< 2	375	3.48	92	54800	7700	23500
40	< 2	390	2.54	80	53000	7900	22300
41	< 2	390	1.77	81	55600	8600	30600
42	< 2	360	2.46	82	54600	8000	23000
43	< 2	210	1.10	75	53800	8400	21800
44	< 2	270	0.35	50	44000	33800	17200
45	< 2	225	0.93	56	46000	5000	17300
46	< 2	105	0.57	51	44500	5400	15800
47	< 2	285	1.49	72	52100	7200	24400
48	< 2	450	3.58	81	54000	8200	24600
49	< 2	300	0.31	67	61100	22600	22500
50	< 2	510	2.10	86	62300	8000	26100
51	< 2	225	0.85	72	55800	9500	22500
52	< 2	420	1.45	84	59300	10000	23500
53	< 2	465	1.18	94	63200	11200	30800
54	< 2	435	2.14	90	61700	8300	26700
55	7	105	0.24	74	63100	31100	23800
56	< 2	390	2.02	84	57000	8000	22400
57	< 2	465	2.52	82	55400	7200	28100
58	< 2	375	1.67	110	69700	9200	31500
59	< 2	405	1.60	105	67700	8900	30600
60	< 2	375	2.22	73	53600	7800	21200
61	< 2	315	1.31	74	55600	7800	25500
62	< 2	405	2.86	86	50600	6200	25600
63	< 2	585	1.72	97	63400	8300	30200
64	< 2	285	0.56	68	59900	31100	28700

A . INDICATES MISSING DATA.

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT						
	S		ZN		AL	CA	FE
	E	T	E	T	T	T	T

A < INDICATES THE CONCENTRATION WAS LESS THAN THE DETECTABLE LEVEL.

E - EXTRACTABLE CONCENTRATION. T - TOTAL CONCENTRATION

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT				
	K T	MG T	MN T	NA T	TI T
SAMPLING DEPTH = 1.3 CM					
1	16300	6500	448	9800	2800
2	18000	5600	461	11200	3100
6	17800	8400	580	10600	3000
7	16400	5900	426	10500	2900
8	21400	11700	680	8000	3600
9	17800	7200	535	10800	3300
10	17200	8100	515	11000	3300
11	18300	5400	545	11400	3700
12	19200	7800	555	11600	3300
15	10500	5100	580	10500	2700
21	16700	6300	530	9600	3000
22	15900	4900	472	11400	2900
23	15900	5800	434	10600	2800
30	17800	6500	545	9700	3100
31	16000	5100	426	9400	2800
42	16100	6200	466	9600	2900
43	17000	5200	500	10800	3000
47	15600	4500	412	11400	2400
55	15900	7000	438	9800	2900
63	17800	8000	565	7800	3200
SAMPLING DEPTH = 10. CM					
1	16000	8700	367	9800	2700
2	16600	5800	408	11600	3000
3	16800	5500	418	11700	3000
4	16500	6600	407	13400	3000
5	18100	5800	505	10700	3200
6	17200	6400	485	12200	2700
7	17000	6400	434	11400	3000
8	19200	13800	484	8400	3200
9	17500	7700	384	10800	3200
10	16700	10200	414	9700	3000
11	16700	4900	960	10900	2900
12	19000	6200	515	12700	3100
13	17800	6200	484	10200	3000
14	16100	4600	404	10700	2800
15	16400	4100	361	11900	2700
16	17900	6400	565	10500	3000
17	16800	5000	416	11000	3100
18	15600	5200	196	12000	2300
19	16300	7400	410	8600	3000
20	15000	9600	408	9500	2600

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT K T	 MG T	 MN T	 NA T	 TI T
21	13500	19000	543	5500	2200
22	13100	4600	336	9600	2400
23	15100	5400	407	9200	2700
24	14800	5700	466	10400	2700
25	14700	4900	405	10200	2800
26	13900	5000	326	13600	2600
27	15000	5800	476	8500	2800
28	15400	6000	454	8400	2900
29	14400	5800	366	11000	2500
30	15800	5600	429	9200	2900
31	16100	4900	417	9800	2800
32	17200	6600	525	9500	3100
33	15800	5200	419	10400	2800
34	15600	4400	437	13000	2300
35	14200	6400	715	7300	2800
36	16300	5400	540	9200	2700
37	14400	6200	479	8800	2800
38	14900	5400	399	7600	2800
39	17800	5500	605	10400	3300
40	17600	5600	492	10800	3200
41	18000	5600	575	11600	3200
42	17800	6000	500	10400	3200
43	17400	6000	510	11300	3200
44	17600	9800	296	8600	2500
45	15400	3700	274	10400	2800
46	14200	4000	240	12000	2500
47	15400	5100	482	12600	2900
48	13600	5800	525	10800	3100
49	15900	6700	431	14400	3000
50	19900	7500	383	9500	3400
51	17400	6400	445	12000	3100
52	20200	8000	490	15600	3300
53	20100	8800	835	10600	3700
54	19500	6700	565	10600	3700
55	17000	16600	480	12600	2800
56	18200	5600	565	11800	3300
57	16000	5500	630	10400	3100
58	20400	8400	615	9000	3800
59	20100	8200	585	9100	3700
60	17200	5900	397	11400	2900
61	17600	6100	415	11000	3000
62	17600	6500	660	10400	3200
63	19200	9000	570	8400	3400
64	16000	13800	455	10500	3000

A . INDICATES MISSING DATA.

SOIL ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT K T	MG T	MN T	NA T	TI T

T - TOTAL CONCENTRATION

Vegetation Section

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

SPECIES = AGROPYRON SMITHII (WESTERN WHEATGRASS)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT					
		AL	CD	CR	CU	FE	PB
1	71378	44	< 0.1	4.3	3.5	66	< 3
2	71378	61	< 0.1	7.6	2.8	92	< 3
4	71378	34	0.2	2.2	2.5	49	< 3
6	71378	55	< 0.1	3.7	2.8	69	< 3
7	71378	43	< 0.1	4.8	2.6	66	< 3
9	71278	52	< 0.1	2.2	2.7	60	< 3
11	71278	26	< 0.1	2.4	2.2	49	< 3
12	72078	188	< 0.1	7.4	3.4	201	< 3
13	71278	57	< 0.1	3.1	2.4	81	< 3
14	71278	63	0.1	3.4	3.0	88	< 3
15	71278	29	< 0.1	1.8	2.8	54	< 3
17	71378	29	0.8	2.0	2.6	50	< 3
18	62978	35	< 0.1	1.8	3.3	51	< 3
19	71878	76	< 0.1	2.7	2.8	86	< 3
20	71878	115	< 0.1	3.2	2.8	125	< 3
21	71878	94	< 0.1	2.9	2.9	100	< 3
22	71378	28	< 0.1	2.6	3.2	40	< 3
23	71378	45	< 0.1	3.2	2.0	62	< 3
24	72078	71	< 0.1	4.2	3.2	93	< 3
25	72078	88	< 0.1	4.2	4.0	98	< 3
26	71278	125	< 0.1	6.8	3.0	140	< 3
30	71278	127	< 0.1	7.5	3.2	136	< 3
31	71278	72	< 0.1	2.6	2.6	76	< 3
32	71278	33	< 0.1	1.8	2.4	47	< 3
35	72078	99	< 0.1	5.0	2.6	104	< 3
38	71278	52	< 0.1	3.2	3.0	64	< 3
39	71878	72	< 0.1	2.7	2.4	77	< 3
40	71878	130	< 0.1	4.0	2.8	91	< 3
41	71878	56	< 0.1	4.0	2.5	78	< 3
42	71278	81	< 0.1	4.9	2.7	98	< 3
43	71878	30	< 0.1	3.0	2.4	48	< 3
44	71878	74	< 0.1	2.8	2.6	97	< 3
45	71878	45	< 0.1	2.8	2.5	72	< 3
46	71878	100	< 0.1	3.0	2.7	126	< 3
47	72078	199	< 0.1	8.6	2.6	202	< 3
49	72078	44	< 0.1	2.4	2.4	57	< 3
51	72078	308	< 0.1	15.6	3.5	314	< 3
52	72078	33	< 0.1	2.4	2.4	54	< 3
53	72078	49	< 0.1	3.8	3.2	75	< 3
54	72078	54	< 0.1	1.6	2.7	61	< 3
55	71278	189	< 0.1	7.4	2.9	184	< 3
56	71278	46	< 0.1	1.2	2.8	62	< 3
57	71278	51	< 0.1	1.6	2.6	65	< 3
58	71278	252	< 0.1	5.9	1.8	216	< 3
61	72078	120	< 0.1	5.4	2.8	131	< 3

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT AL	 CD	 CR	 CU	 FE	 PB
62	72078	48	< 0.1	2.2	3.0	65	< 3
64	71378	26	< 0.1	2.4	2.2	43	< 3
SPECIES = ANDROPOGON SCOPARIUS (LITTLE BLUESTEM)							
1	81678	84	< 0.1	15.5	2.4	134	< 3
9	81778	68	< 0.1	11.4	2.5	96	< 3
11	81778	74	< 0.1	18.3	2.0	131	< 3
15	81778	54	< 0.1	10.2	2.1	84	< 3
19	81678	82	< 0.1	10.6	1.6	106	< 3
20	81678	104	< 0.1	10.1	2.1	130	< 3
21	81678	184	< 0.1	20.8	2.0	230	< 3
22	81678	142	< 0.1	15.2	2.2	174	< 3
30	81778	70	< 0.1	10.6	2.6	103	< 3
31	81778	118	< 0.1	19.6	3.3	166	< 3
39	81678	155	0.1	15.6	3.0	182	< 3
41	81678	176	0.1	21.6	2.2	215	< 3
42	81678	246	0.1	21.9	2.6	294	< 3
44	81678	196	0.1	17.7	2.4	240	< 3
46	81678	193	0.1	21.2	2.6	240	< 3
47	81778	82	0.1	11.8	3.0	104	< 3
49	81778	296	0.1	35.4	2.8	338	< 3
50	81778	166	0.1	26.7	2.6	226	< 3
51	81778	160	< 0.1	26.9	2.8	223	< 3
52	81778	310	0.1	52.5	3.2	432	< 3
60	81778	236	0.1	33.4	3.4	310	< 3
SPECIES = CAREX ELEOCHARIS (NEEDLELEAF SEDGE)							
1	71378	157	< 0.1	3.8	3.1	150	< 3
2	71378	226	0.2	5.6	2.9	225	< 3
4	71378	153	< 0.1	2.4	2.4	149	< 3
7	71378	329	< 0.1	7.4	2.8	299	< 3
10	71278	218	< 0.1	3.0	2.6	180	< 3
13	71278	301	0.1	3.0	3.6	280	< 3
15	71278	97	< 0.1	2.4	2.0	119	< 3
19	71878	239	0.2	3.4	2.3	207	< 3
20	71878	324	< 0.1	2.5	2.5	251	< 3
21	71878	369	< 0.1	2.8	2.4	265	< 3
22	71378	119	< 0.1	2.6	2.3	136	< 3
24	72078	234	< 0.1	3.6	2.1	217	< 3
29	71278	311	< 0.1	2.6	2.6	284	< 3
30	71278	372	< 0.1	2.6	2.8	287	< 3
31	71278	196	< 0.1	2.2	2.6	182	< 3
34	72078	365	< 0.1	2.6	1.8	335	< 3
35	72078	234	< 0.1	3.2	2.0	197	< 3
38	71278	147	< 0.1	1.8	3.0	142	< 3

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT					
		AL	CD	CR	CU	FE	PB
39	71878	161	< 0.1	2.4	2.4	143	< 3
40	71878	490	< 0.1	3.4	2.6	348	< 3
41	71878	259	< 0.1	2.8	2.4	213	< 3
43	71878	173	< 0.1	4.2	2.4	155	< 3
44	71878	320	< 0.1	2.8	2.4	246	< 3
45	71878	230	0.1	2.6	2.4	187	< 3
46	71878	347	< 0.1	3.2	2.5	263	< 3
47	72078	341	0.2	3.1	2.6	312	< 3
49	72078	383	0.2	3.0	2.1	265	< 3
50	72078	665	0.2	4.8	1.8	560	< 3
51	72078	223	< 0.1	2.0	2.3	190	< 3
52	72078	284	0.1	1.6	2.1	244	< 3
53	72078	245	< 0.1	2.6	2.6	219	< 3
54	72078	159	< 0.1	1.4	2.4	146	< 3
55	71278	224	0.1	2.2	2.8	205	< 3
SPECIES = KOELERIA CRISTATA (JUNE GRASS)							
1	62178	64	< 0.1	1.0	3.5	76	< 3
2	62178	77	< 0.1	1.6	4.0	83	< 3
3	62178	88	< 0.1	1.9	4.1	95	< 3
4	62178	46	< 0.1	1.0	4.1	58	< 3
6	62178	77	< 0.1	2.4	5.0	84	< 3
7	62278	70	< 0.1	1.7	3.0	80	< 3
8	62178	80	< 0.1	2.0	4.1	91	< 3
9	62378	70	< 0.1	1.4	3.7	77	< 3
10	62378	37	< 0.1	1.4	3.4	54	< 3
11	62378	40	< 0.1	1.4	3.2	54	< 3
13	62278	112	0.1	2.4	3.8	144	< 3
14	62278	110	0.1	2.1	4.2	132	< 3
15	62378	42	< 0.1	1.7	4.2	62	< 3
16	62378	70	< 0.1	1.6	2.8	93	< 3
17	62378	75	0.1	1.5	3.2	89	< 3
19	62978	68	< 0.1	1.8	2.0	75	< 3
20	62978	142	< 0.1	1.8	2.6	140	< 3
21	62978	58	< 0.1	1.4	2.4	71	< 3
22	62178	70	0.1	1.5	4.2	82	< 3
23	62178	93	< 0.1	2.3	3.6	100	< 3
24	63078	439	< 0.1	6.1	3.6	378	< 3
25	63078	233	0.1	4.6	2.8	223	< 3
26	63078	170	< 0.1	3.8	2.4	174	< 3
27	62278	348	0.1	5.6	3.2	273	< 3
28	62278	87	0.1	2.0	2.6	88	< 3
29	62278	188	< 0.1	3.2	5.7	198	< 3
30	62278	192	< 0.1	4.0	2.8	174	< 3
31	62278	112	< 0.1	2.0	2.2	107	< 3
32	62978	77	< 0.1	1.0	2.6	91	< 3
35	62278	242	< 0.1	2.2	2.6	192	< 3

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT					
		AL	CD	CR	CU	FE	PB
36	70678	141	< 0.1	2.2	3.2	126	< 3
38	62978	197	< 0.1	4.0	2.7	168	< 3
39	62378	448	< 0.1	13.1	3.0	395	< 3
40	62378	78	< 0.1	1.8	2.4	92	< 3
42	62378	78	< 0.1	0.8	3.0	99	< 3
43	62378	122	< 0.1	2.2	2.8	156	< 3
49	63078	84	< 0.1	1.9	1.8	91	< 3
50	63078	107	< 0.1	3.0	2.0	114	< 3
51	63078	149	< 0.1	2.4	2.5	139	< 3
52	63078	117	< 0.1	2.1	2.4	112	< 3
53	63078	155	< 0.1	3.6	2.4	150	< 3
54	63078	286	< 0.1	4.0	2.9	265	< 3
55	62278	125	< 0.1	2.0	2.4	135	< 3
56	62978	79	< 0.1	1.9	2.8	89	< 3
61	70678	164	< 0.1	2.8	2.8	146	< 3
62	70678	264	< 0.1	4.6	3.0	236	< 3
SPECIES = KOELERIA CRISTATA (JUNE GRASS)							
1	92178	239	< 0.1	22.2	1.8	283	< 3
2	92178	311	< 0.1	27.1	1.6	353	< 3
7	92278	350	< 0.1	28.3	1.7	384	< 3
9	92178	259	0.1	18.3	1.5	273	4
10	92178	160	< 0.1	22.2	1.6	218	< 3
11	92178	190	0.1	21.0	1.5	230	< 3
15	92178	145	< 0.1	5.6	1.2	157	4
21	92178	216	< 0.1	14.2	1.4	232	< 3
22	92178	231	0.1	22.2	1.4	275	< 3
24	92178	448	< 0.1	28.8	1.6	450	< 3
25	92178	730	0.1	71.5	2.4	845	< 3
26	92178	500	< 0.1	40.4	2.2	570	< 3
30	92178	515	< 0.1	34.8	1.8	525	< 3
31	92178	362	< 0.1	20.5	1.8	353	< 3
43	92278	350	< 0.1	27.2	1.6	458	< 3
47	92278	925	< 0.1	68.0	2.0	970	< 3
55	92278	375	< 0.1	28.1	1.8	441	< 3
SPECIES = OXYTROPIS LAMBERTII (PURPLE LOCO)							
2	60178	89	0.2	1.4	4.9	109	< 3
15	60778	59	< 0.1	1.0	4.4	80	< 3
16	60778	82	< 0.1	0.8	4.0	98	< 3
18	60778	58	< 0.1	0.7	3.6	79	< 3
19	60778	85	< 0.1	0.9	7.1	96	< 3
21	60778	60	< 0.1	0.7	3.0	81	< 3
22	60778	58	0.1	1.0	3.1	71	< 3
26	60878	164	< 0.1	0.6	2.4	149	< 3

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT					
		AL	CD	CR	CU	FE	PB
27	60878	239	< 0.1	0.8	3.3	189	< 3
28	60878	156	< 0.1	0.8	3.3	131	< 3
29	60878	127	< 0.1	1.0	3.0	127	< 3
30	60878	98	< 0.1	0.9	3.8	105	< 3
31	60878	90	< 0.1	0.9	2.8	96	< 3
32	60978	52	< 0.1	0.8	5.0	64	< 3
35	60978	279	< 0.1	1.4	4.2	226	< 3
37	60978	86	< 0.1	0.8	2.9	88	< 3
38	60978	74	< 0.1	1.0	3.4	82	< 3
39	61378	65	< 0.1	0.7	5.1	74	< 3
40	61378	56	< 0.1	0.8	4.3	67	< 3
41	61378	119	< 0.1	0.7	5.2	114	< 3
42	61378	138	0.1	1.1	5.6	133	< 3
43	61378	183	0.1	1.2	4.2	181	< 3
44	61378	94	< 0.1	0.6	4.0	102	< 3
45	61378	105	0.1	1.0	5.0	98	< 3
46	61378	64	< 0.1	0.9	3.6	76	< 3
47	61478	194	< 0.1	1.2	5.8	170	< 3
48	61478	74	< 0.1	0.7	4.9	83	< 3
49	61478	86	0.1	1.4	3.6	86	< 3
50	61478	87	0.1	0.8	3.6	94	< 3
51	61478	207	< 0.1	1.2	4.6	67	< 3
52	61478	56	< 0.1	1.0	4.0	66	< 3
53	61478	91	< 0.1	0.8	4.1	94	< 3
54	61478	101	< 0.1	1.0	4.2	95	< 3
SPECIES = STIPA COMATA (NEEDLE AND THREAD)							
1	62178	21	< 0.1	1.8	3.8	41	< 3
2	62178	30	< 0.1	4.2	3.6	55	< 3
3	62178	11	< 0.1	2.4	2.6	37	< 3
4	62178	11	< 0.1	2.1	3.4	34	< 3
6	62178	30	< 0.1	1.8	3.4	41	< 3
7	62278	38	0.1	1.7	3.4	47	< 3
8	62178	38	< 0.1	8.1	3.2	71	< 3
9	62378	28	< 0.1	1.8	3.2	74	< 3
10	62378	21	< 0.1	1.8	3.0	38	< 3
11	62378	28	< 0.1	1.8	3.2	40	< 3
13	62278	24	< 0.1	1.4	3.1	52	< 3
14	62278	35	< 0.1	3.7	3.0	65	< 3
15	62378	22	< 0.1	1.6	3.5	34	< 3
16	62378	38	< 0.1	1.2	3.2	47	< 3
17	62378	15	< 0.1	7.4	2.9	38	< 3
18	62978	35	< 0.1	1.1	2.4	40	< 3
19	62978	32	< 0.1	1.2	2.8	38	< 3
20	62978	40	< 0.1	1.2	2.5	48	< 3
21	62978	28	< 0.1	1.1	3.0	34	< 3
22	62178	31	< 0.1	2.7	3.8	46	< 3

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT AL	 CD	 CR	 CU	 FE	 PB
23	62178	39	< 0.1	2.5	3.9	50	< 3
24	63078	159	< 0.1	6.8	3.0	167	< 3
25	63078	48	< 0.1	2.1	3.1	58	< 3
26	63078	105	0.1	2.8	2.0	120	< 3
27	62278	32	< 0.1	2.5	3.0	45	< 3
28	62278	77	< 0.1	2.5	3.6	73	< 3
29	62278	37	0.1	3.4	3.4	54	< 3
30	62278	20	< 0.1	3.6	2.8	46	< 3
31	62278	43	< 0.1	6.6	3.0	73	< 3
32	62978	18	< 0.1	0.9	2.8	31	< 3
35	62278	58	< 0.1	1.6	2.2	56	< 3
36	70678	60	< 0.1	4.0	2.5	72	< 3
38	62978	19	< 0.1	1.4	2.4	32	< 3
39	62378	42	< 0.1	1.8	2.8	55	< 3
40	62378	35	< 0.1	2.2	2.9	43	< 3
42	62378	29	< 0.1	2.6	3.8	51	< 3
43	62378	66	< 0.1	5.4	3.0	98	< 3
49	63078	18	< 0.1	2.4	2.3	39	< 3
50	63078	87	< 0.1	2.4	2.6	89	< 3
51	63078	27	< 0.1	1.3	2.6	37	< 3
52	63078	45	< 0.1	1.3	2.6	45	< 3
53	63078	37	< 0.1	2.2	2.3	46	< 3
54	63078	48	< 0.1	2.3	2.5	54	< 3
55	62278	43	< 0.1	1.8	3.1	55	< 3
56	62978	31	< 0.1	1.2	2.4	41	< 3
60	70678	28	< 0.1	1.3	2.8	39	< 3
61	70678	35	< 0.1	1.4	3.0	43	< 3
62	70678	37	< 0.1	1.2	2.6	45	< 3

SPECIES = VICIA AMERICANA (VETCH)

LOCATION NUMBER	SAMPLING DATE	AL	CD	CR	CU	FE	PB
1	60178	78	0.1	1.4	8.0	98	< 3
4	60178	68	< 0.1	1.0	8.2	92	< 3
5	60178	112	0.1	2.8	7.4	134	< 3
6	60178	299	< 0.1	2.0	6.7	244	< 3
7	60178	102	< 0.1	1.6	7.6	118	< 3
8	60178	99	< 0.1	1.2	6.5	101	< 3
9	60278	87	< 0.1	1.0	8.3	93	< 3
10	60278	89	< 0.1	0.8	7.8	96	< 3
11	60278	57	< 0.1	0.7	8.9	84	< 3
12	60278	180	0.1	1.2	8.0	171	< 3
13	60278	136	0.1	1.1	6.4	141	< 3
14	60278	120	< 0.1	1.2	7.2	136	< 3
19	60778	108	< 0.1	1.2	4.4	103	< 3
23	60778	100	< 0.1	1.2	3.4	107	< 3
24	60878	264	< 0.1	1.8	6.4	256	< 3

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	SAMPLING DATE	TRACE ELEMENT AL	CD	CR	CU	FE	PB
33	60978	70	< 0.1	0.8	7.0	82	< 3
34	60978	246	< 0.1	1.0	3.4	242	< 3
36	60978	71	< 0.1	1.0	6.6	87	< 3

A . INDICATES MISSING DATA.

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VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	TRACE ELEMENT				
	MO	NI	SE	S	ZN
SPECIES = AGROPYRON SMITHII (WESTERN WHEATGRASS)					
1	0.6	2.8	0.45	800	16.6
2	1.4	5.4	0.34	800	15.6
4	1.4	1.5	0.42	1000	15.5
6	0.8	2.2	0.18	1000	14.0
7	0.6	3.0	0.31	800	13.2
9	1.8	1.4	0.15	1000	13.6
11	0.3	1.2	0.19	500	12.2
12	1.4	4.7	0.24	1100	15.2
13	1.0	2.2	0.08	800	14.4
14	0.8	2.2	0.16	700	15.0
15	1.5	1.2	0.10	800	12.6
17	0.2	1.2	0.19	1200	16.0
18	0.6	1.3	0.20	1200	20.6
19	0.6	1.6	0.09	1100	14.0
20	1.0	2.1	0.12	1900	18.0
21	0.7	1.8	0.10	900	14.7
22	1.0	1.5	0.26	800	12.1
23	0.8	2.0	0.30	500	17.0
24	0.8	2.8	0.23	1300	18.4
25	0.6	2.6	0.15	800	23.2
26	2.1	4.4	0.29	1000	18.8
30	1.4	4.8	0.31	1100	16.2
31	0.4	1.8	0.12	1000	13.6
32	0.4	1.2	0.26	1200	16.4
35	1.4	3.3	0.10	1400	20.2
38	0.5	1.9	0.26	1000	16.3
39	1.0	1.7	0.09	1800	14.3
40	1.0	2.6	0.12	1200	15.4
41	1.2	2.8	0.07	1100	14.4
42	0.9	3.4	0.19	1100	14.9
43	0.9	1.8	0.09	700	13.4
44	1.1	1.8	0.14	1800	17.3
45	1.3	1.6	0.21	1200	21.3
46	2.1	1.9	0.28	1500	21.8
47	1.2	5.2	0.14	1100	16.8
49	0.4	1.4	0.22	1500	10.6
51	1.4	10.0	0.30	1700	18.2
52	1.3	2.8	0.21	1200	15.6
53	1.1	3.2	0.65	1400	12.0
54	1.8	1.6	0.60	1200	17.4
55	2.2	4.8	0.74	1300	18.0
56	0.4	1.2	0.13	1200	15.6
57	0.2	1.4	0.22	1200	15.2
58	0.9	3.6	0.39	800	8.0
61	1.0	3.8	0.33	1200	15.8

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	MO	NI	SE	S	ZN
62	0.5	1.8	0.53	1400	16.2
64	2.0	1.6	0.23	1100	15.0

SPECIES = ANDROPOGON SCUPARIUS (LITTLE BLUESTEM)

LOCATION NUMBER	MO	NI	SE	S	ZN
1	1.2	9.6	0.06	< 100	11.8
9	0.8	7.2	0.11	< 100	12.4
11	1.3	10.8	0.06	< 100	11.1
15	0.8	6.2	0.09	< 100	11.8
19	0.5	6.2	0.05	< 100	9.4
20	1.2	6.3	0.05	< 100	10.4
21	1.0	12.0	0.04	< 100	8.4
22	1.2	9.6	0.08	< 100	12.8
30	1.4	6.8	0.10	< 100	15.2
31	2.2	11.5	0.11	< 100	15.8
39	1.3	9.2	0.07	< 100	12.6
41	2.0	13.0	0.05	< 100	8.8
42	1.8	12.8	0.26	< 100	10.8
44	1.3	10.5	0.08	< 100	12.6
46	1.5	12.7	0.06	< 100	11.4
47	1.6	7.2	0.10	< 100	13.4
49	2.6	21.0	0.13	< 100	16.6
50	1.8	15.2	0.16	< 100	12.0
51	2.1	15.9	0.13	100	19.9
52	4.8	33.4	0.18	< 100	14.2
60	3.0	20.2	0.14	< 100	18.9

SPECIES = CAREX ELEOCHARIS (NEEDLELEAF SEDGE)

LOCATION NUMBER	MO	NI	SE	S	ZN
1	0.6	2.8	0.13	1000	21.6
2	1.2	4.0	0.80	1000	24.0
4	0.7	1.6	0.31	1100	14.4
7	1.3	5.4	0.82	1200	17.8
10	0.7	2.0	0.12	1000	12.1
13	1.0	2.0	0.17	900	30.2
15	0.8	1.6	0.19	800	13.4
19	0.6	2.1	0.08	900	15.0
20	0.8	1.8	0.17	1100	10.4
21	0.5	1.8	0.12	1100	9.7
22	0.4	1.9	0.36	1100	8.0
24	0.6	2.4	0.11	900	13.4
29	0.9	1.8	0.14	1100	12.3
30	0.8	1.8	0.28	900	13.4
31	0.5	1.5	0.17	1800	14.6
34	0.6	1.8	0.08	900	11.3
35	0.8	2.2	0.09	900	14.0
38	0.6	1.4	0.26	900	18.2

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	TRACE ELEMENT MO	NI	SE	S	ZN
39	0.6	1.6	0.14	900	11.0
40	0.9	2.4	0.14	1000	8.4
41	0.6	2.1	0.15	900	8.8
43	1.1	3.2	0.18	1000	10.2
44	0.9	1.7	0.12	1000	9.0
45	0.7	1.8	0.11	1000	9.7
46	0.7	1.8	0.13	1000	9.6
47	0.8	1.8	0.11	1000	19.2
49	0.6	2.0	0.08	1000	11.7
50	0.8	2.6	0.05	900	7.5
51	0.6	1.4	0.44	1000	9.9
52	0.6	1.1	0.14	900	11.8
53	0.9	1.6	0.65	1000	12.8
54	0.3	1.1	0.46	700	14.4
55	0.8	1.8	0.54	1000	14.7
SPECIES = KOELERIA CRISTATA (JUNE GRASS)					
1	0.6	3.4	0.22	900	24.0
2	1.0	3.5	0.20	700	24.8
3	1.0	3.8	0.11	800	21.0
4	1.2	2.9	0.37	1600	18.9
6	1.6	4.4	0.36	1000	21.4
7	0.9	4.1	0.34	800	17.0
8	0.8	2.6	0.10	900	20.8
9	1.4	3.2	0.09	700	17.1
10	1.0	3.1	0.08	700	16.8
11	0.8	1.8	0.13	200	14.8
13	1.8	3.4	0.08	700	22.1
14	1.2	3.2	0.14	900	21.8
15	1.0	3.3	0.10	700	17.0
16	1.6	3.1	0.09	800	19.0
17	1.0	3.4	0.26	800	22.2
19	0.1	2.2	0.07	1300	15.4
20	0.7	3.6	0.11	1500	17.5
21	0.2	2.2	0.03	1100	18.0
22	6.8	3.4	0.14	1100	21.6
23	1.0	3.6	0.14	1000	20.2
24	1.0	5.6	0.13	2100	30.2
25	1.4	4.2	0.32	1100	21.3
26	0.6	3.6	0.04	2400	20.2
27	3.0	6.1	0.17	900	20.0
28	1.2	3.9	0.43	700	18.0
29	0.8	4.7	0.06	900	16.7
30	1.2	4.2	0.19	800	20.2
31	0.2	2.8	0.10	800	19.6
32	0.7	2.8	0.10	1600	22.4
35	1.0	2.6	0.05	1400	19.0

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	TRACE ELEMENT MO	NI	SE	S	ZN
36	0.8	3.2	0.21	1300	22.2
38	1.0	4.3	0.36	900	18.6
39	1.5	10.8	0.17	800	22.8
40	0.8	2.8	0.07	800	21.1
42	1.4	3.2	0.15	900	22.5
43	0.9	3.0	0.18	1900	21.2
49	0.4	3.2	0.10	900	14.6
50	0.8	2.8	0.16	600	15.1
51	0.8	3.4	0.23	900	19.0
52	0.6	2.2	0.10	900	20.7
53	0.8	4.2	0.08	900	16.3
54	1.0	5.0	0.10	1100	18.8
55	1.0	3.8	0.15	800	17.8
56	0.8	2.8	0.10	800	18.8
61	0.8	3.3	0.15	1300	21.0
62	0.8	4.6	0.06	1300	26.6
SPECIES = KOELERIA CRISTATA (JUNE GRASS)					
1	1.5	13.0	0.13	300	14.2
2	2.0	15.2	0.15	100	25.6
7	1.5	15.0	0.12	200	7.7
9	1.6	10.8	0.07	100	8.6
10	2.7	14.7	0.05	100	8.7
11	1.6	12.3	0.06	100	11.1
15	1.2	4.0	0.06	100	8.9
21	0.9	8.6	0.07	200	10.4
22	1.2	12.3	0.08	100	10.3
24	2.4	17.0	0.08	< 100	8.3
25	5.7	43.8	0.10	100	10.2
26	2.4	23.2	0.07	100	7.8
30	2.3	19.8	0.11	200	10.1
31	1.4	11.9	0.07	100	8.6
43	2.0	16.2	0.09	100	8.5
47	5.2	40.6	0.11	100	10.6
55	2.7	17.1	0.09	100	10.7
SPECIES = OXYTROPIS LAMBERTII (PURPLE LOCO)					
2	2.2	3.8	0.63	1800	19.0
15	1.8	2.7	0.19	1500	12.0
16	1.4	2.8	0.26	1500	10.6
18	0.4	2.2	0.11	1700	12.8
19	0.2	2.0	0.22	2100	19.2
21	1.0	2.5	0.10	1400	10.0
22	0.8	2.3	0.35	1700	11.2
26	0.4	2.7	0.15	1200	10.1

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	TRACE ELEMENT MO	NI	SE	S	ZN
27	1.4	2.6	0.18	1700	10.4
28	1.0	2.9	0.50	1400	10.8
29	0.6	2.5	0.17	1400	11.2
30	1.0	3.0	0.20	1400	13.0
31	0.9	2.6	0.14	1400	10.6
32	1.9	3.2	0.39	1400	12.2
35	2.0	2.8	0.15	1500	10.0
37	0.6	2.2	0.29	1300	11.0
38	1.5	2.5	0.37	1800	10.8
39	0.6	2.4	0.37	1200	9.4
40	0.6	2.8	0.36	1300	8.7
41	1.7	2.5	0.14	1200	10.4
42	2.2	2.7	0.27	1300	10.8
43	0.8	2.8	0.19	1300	8.6
44	0.8	1.4	0.13	1200	12.2
45	0.6	2.6	0.17	1500	12.6
46	0.4	2.6	0.09	1400	10.8
47	0.4	2.4	0.14	1400	9.0
48	0.3	1.6	0.09	1600	9.4
49	1.0	2.2	0.16	2000	7.8
50	1.2	2.0	0.09	2500	10.8
51	1.6	2.6	0.22	1200	9.3
52	1.4	2.6	0.16	1400	10.5
53	1.2	2.5	0.24	1200	9.6
54	1.0	2.4	0.27	1100	7.8

SPECIES = STIPA COMATA (NEEDLE AND THREAD)

LOCATION NUMBER	MO	NI	SE	S	ZN
1	0.5	2.2	0.09	800	12.2
2	0.6	4.0	0.07	800	15.2
3	0.2	4.0	0.07	800	10.6
4	0.8	2.4	0.13	800	12.0
6	1.2	2.4	0.18	900	11.8
7	0.4	2.6	0.15	1000	12.3
8	1.2	6.0	0.11	1100	10.8
9	0.6	2.4	0.21	900	12.6
10	0.6	2.8	0.06	800	11.8
11	0.2	2.1	0.14	1300	12.0
13	0.5	3.6	0.04	800	13.4
14	0.5	3.6	0.13	900	13.4
15	0.3	2.2	0.10	900	13.0
16	0.5	2.3	0.11	900	13.5
17	0.3	2.1	0.19	900	13.4
18	0.3	1.7	0.16	700	11.6
19	0.3	1.7	0.06	700	11.2
20	0.5	2.4	0.07	700	11.1
21	0.4	1.6	0.04	600	12.6
22	0.4	2.5	0.09	1000	13.1

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	TRACE ELEMENT MO	 NI	 SE	 S	 ZN
23	0.5	2.4	0.10	900	13.8
24	1.1	5.1	0.16	800	16.6
25	0.6	2.4	0.22	900	16.4
26	0.5	3.1	0.04	600	7.4
27	< 0.2	2.4	0.06	900	12.4
28	0.3	2.8	0.07	1000	14.3
29	1.0	3.9	0.27	1000	13.7
30	0.4	4.1	0.04	700	11.3
31	0.7	5.4	0.08	1000	12.0
32	0.4	1.8	0.11	900	13.1
35	0.3	2.0	0.05	200	9.2
36	0.8	4.0	0.16	1400	11.6
38	0.1	1.6	0.14	100	10.2
39	< 0.2	2.2	0.05	800	12.0
40	0.4	2.6	0.04	400	11.6
42	0.4	3.4	0.10	800	12.6
43	0.2	4.7	0.09	800	12.4
49	0.4	3.3	0.03	200	11.7
50	0.6	2.8	0.06	800	11.8
51	0.4	2.1	0.56	100	11.0
52	0.4	2.1	0.56	100	11.0
53	0.6	2.7	0.07	100	10.4
54	0.5	3.0	0.08	100	9.6
55	0.6	2.6	0.16	900	12.8
56	0.2	1.8	0.07	< 100	11.0
60	0.6	1.8	0.19	800	12.2
61	0.5	1.9	0.15	800	12.8
62	0.6	1.8	0.04	700	13.2
SPECIES = VICIA AMERICANA (VETCH)					
1	1.0	3.5	0.28	2000	38.4
4	1.2	2.6	0.47	2000	35.4
5	1.7	4.4	1.29	2200	41.2
6	2.0	2.8	0.16	3500	27.8
7	0.8	3.6	0.93	2400	31.4
8	1.6	2.8	0.21	2200	29.4
9	0.8	2.6	0.26	2300	24.8
10	0.4	2.0	0.19	2000	30.2
11	0.6	3.2	0.48	1800	34.6
12	0.7	2.4	0.35	3000	35.6
13	2.2	3.2	0.40	2400	36.2
14	0.8	3.0	0.35	1900	35.2
19	0.6	3.0	0.11	1300	15.0
23	0.6	2.8	0.23	1400	11.6
24	1.4	2.6	0.43	2500	36.0

VEGETATION TRACE ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	TRACE ELEMENT				
	MO	NI	SE	S	ZN
33	0.3	2.6	0.44	2100	36.8
34	0.2	2.4	0.24	2700	26.8
36	0.6	2.5	0.32	2300	36.6

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VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT					
	CA	K	MN	MG	NA	P
SPECIES = AGROPYRON SMITHII (WESTERN WHEATGRASS)						
1	1800	15700	28	1000	40	1300
2	2400	15200	40	1200	50	1300
4	1900	13400	30	1100	40	1500
6	1900	17000	28	1000	40	1600
7	2000	13800	25	800	20	1000
9	2000	16700	23	1000	40	1400
11	1800	14800	35	800	40	1300
12	3400	17300	79	1000	80	1900
13	2200	13100	29	1100	30	1300
14	1600	15000	21	1000	30	1700
15	1900	17000	33	1000	10	1700
17	2200	18600	50	1100	20	1400
18	2800	18200	41	1100	50	2100
19	2100	14000	31	900	40	1400
20	3400	15000	37	900	40	1700
21	2000	14200	26	900	20	1100
22	1700	12400	33	1000	30	1900
23	1800	12400	17	800	40	1100
24	3500	14300	65	1300	40	1800
25	3100	9700	20	900	40	1100
26	2600	12900	21	900	40	1600
30	2000	13600	32	1000	30	1800
31	2100	13500	24	1200	40	1200
32	2000	14300	29	900	40	1300
35	2000	12800	41	900	40	1200
38	1700	13600	23	1200	30	1600
39	2500	13500	29	800	40	1400
40	2000	14200	26	900	30	1300
41	1800	14000	18	800	30	800
42	2000	14400	33	1000	30	1500
43	1300	13200	18	900	50	1100
44	2800	14000	38	800	30	1200
45	2100	12700	33	700	30	1100
46	3000	13600	47	900	40	1100
47	2400	15300	27	1300	60	1800
49	1300	13600	32	1300	50	1200
51	2700	20700	41	1400	50	1400
52	2200	12500	28	1200	40	1500
53	2500	12700	48	1200	60	1300
54	2100	12800	24	1100	90	1300
55	2100	11400	25	1000	50	1200
56	3000	17400	53	1100	140	1600
57	2200	16600	35	1000	50	1800
58	2500	16700	31	1200	190	1300
61	2400	15100	22	1500	50	1400

VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT CA	K	MN	MG	NA	P
62	1900	14700	37	1300	60	1700
64	1600	13600	29	900	50	1300
SPECIES = ANDROPOGON SCOPARIUS (LITTLE BLUESTEM)						
1	1700	8900	23	900	50	700
9	2000	10200	32	1300	60	800
11	1800	8200	30	1100	50	600
15	1800	9600	30	1200	40	800
19	2000	9600	30	1100	60	600
20	2800	11000	24	1200	50	700
21	1800	8000	22	800	80	500
22	2400	10200	55	900	60	900
30	1600	9200	29	1100	40	600
31	1600	9900	28	1100	70	600
39	2600	9100	26	900	40	700
41	2300	9800	30	900	50	600
42	2300	9200	28	1200	50	800
44	2400	9400	26	900	60	700
46	2300	7700	20	800	50	600
47	1400	8600	33	1200	60	500
49	1900	6600	28	1000	70	400
50	1600	8000	24	1100	40	400
51	1800	7800	27	900	50	500
52	2200	8600	28	1100	60	500
60	2200	8000	31	1100	60	500
SPECIES = CAREX ELEOCHARIS (NEEDLELEAF SEDGE)						
1	6300	18300	32	1500	100	900
2	6200	17800	45	1700	70	1100
4	7100	21000	36	1900	70	1100
7	6800	17800	42	1600	80	1000
10	7500	21000	35	1700	80	1100
13	5400	16000	48	1400	70	8100
15	7300	22000	34	1300	60	1000
19	7500	17500	47	2000	100	7700
20	7800	22000	46	2100	80	800
21	8000	22800	40	1900	80	900
22	7900	21900	52	1900	50	1000
24	6200	20000	44	1500	70	1100
29	7900	16500	45	1300	70	1200
30	6300	18500	41	1600	70	1000
31	5300	20300	49	1600	50	1000
34	8300	15600	58	1400	100	900
35	6600	20200	30	1500	70	800
38	5000	19400	42	1800	60	1300

VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT					
	CA	K	MN	MG	NA	P
39	7600	22400	42	1700	70	1000
40	7700	21800	41	2300	80	800
41	7300	20900	45	1800	60	800
43	7300	19300	41	1800	70	900
44	7900	21800	47	1800	60	800
45	7900	21700	40	2200	60	900
46	6900	20900	44	2000	70	800
47	5700	18400	98	2000	80	1400
49	8600	15900	59	1700	80	700
50	9900	16200	65	1500	80	800
51	7400	19500	32	1600	70	800
52	5700	19600	35	1300	90	1000
53	6900	17600	47	1800	90	1000
54	5400	17800	53	1300	80	900
55	6300	20300	37	1600	50	1000
SPECIES = KOELERIA CRISTATA (JUNE GRASS)						
1	2600	14300	61	1300	60	1900
2	2100	13300	67	1000	50	1600
3	2300	14500	60	1200	50	1500
4	2000	14600	59	1000	40	1800
6	2600	14500	72	1100	40	1900
7	2200	13000	56	900	20	1300
8	2700	14200	55	900	60	1600
9	2000	13700	65	900	30	1600
10	2000	13700	55	1100	80	1400
11	1500	13100	44	800	20	1400
13	2200	13700	31	1100	20	1500
14	2200	16600	46	1300	30	2300
15	2100	13400	63	900	20	1500
16	2200	14300	56	1000	30	1600
17	2100	16600	88	1100	30	2200
19	1700	9800	70	900	40	1200
20	2300	10700	71	1200	30	1500
21	2000	12200	61	900	50	1300
22	2400	15300	112	1200	60	2200
23	2300	15300	45	1200	90	1600
24	2400	12500	103	1200	40	2000
25	2300	8800	56	1000	60	1900
26	2300	10100	50	1000	50	1500
27	2300	14800	61	1200	30	1600
28	2500	12800	63	1100	30	1700
29	2600	13100	80	1200	70	1800
30	2200	14300	77	1200	30	2000
31	1600	14100	67	1000	40	1500
32	1600	9900	65	1000	20	1600
35	2200	9900	54	900	40	1300

VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT					
	CA	K	MN	MG	NA	P
36	2100	10600	46	1000	100	1400
38	1900	10400	53	1200	30	1400
39	2100	14100	71	1100	30	1500
40	2000	14600	71	1100	30	1900
42	2700	14200	56	1300	70	1500
43	2300	14000	77	1100	50	1600
49	2100	9000	36	900	30	1000
50	2000	12000	49	700	20	1300
51	1800	10100	38	1000	60	1300
52	2100	11100	57	900	50	1600
53	2200	10300	60	900	30	1200
54	2500	9600	67	1100	40	1300
55	2200	13700	51	1200	70	1700
56	2400	11400	63	1000	30	1400
61	2100	10000	93	1000	80	1900
62	2100	9400	64	1200	50	1600
SPECIES = KOELERIA CRISTATA (JUNE GRASS)						
1	2200	2200	39	700	70	300
2	2200	2000	51	700	80	300
7	2200	2300	31	600	90	200
9	2000	2400	50	600	70	400
10	2200	2400	65	800	80	400
11	1700	2400	47	600	80	400
15	2400	3200	40	500	70	300
21	2200	2400	58	700	70	400
22	2000	2400	76	600	70	400
24	2400	2400	52	700	80	500
25	2500	1900	46	700	90	500
26	2900	1500	52	600	70	400
30	2300	2700	49	800	70	400
31	1800	2200	37	700	70	300
43	2400	2200	41	600	70	300
47	2300	3100	52	700	90	600
55	2600	1900	45	600	70	200
SPECIES = OXYTROPIS LAMBERTII (PURPLE LOCO)						
2	6800	23800	12	3800	80	2600
15	6500	23200	16	3000	60	2000
16	6400	20500	16	3400	70	2100
18	6900	24100	12	2800	60	2400
19	17100	22300	64	3000	60	1900
21	6600	22300	14	3300	80	2300
22	7700	23100	16	3300	90	2500
26	7900	15400	15	2300	100	2200

VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT					
	CA	K	MN	MG	NA	P
27	7000	22800	17	3400	100	2100
28	5600	21100	18	3200	90	1700
29	7900	16500	14	2600	90	2000
30	6500	19700	16	2800	90	1800
31	5800	23200	15	3900	80	2000
32	5400	24100	14	3300	130	2200
35	7400	21400	21	3800	100	1900
37	6200	20700	17	2900	100	1900
38	7300	20400	13	3600	120	1900
39	6700	22000	15	2800	140	2500
40	6100	22400	13	3000	130	2000
41	6600	21200	17	3200	120	1500
42	6900	21900	17	3700	100	2000
43	5700	20100	17	3000	140	1700
44	6600	21400	18	3200	110	1700
45	10000	16700	14	3000	90	2300
46	7000	19000	13	2100	100	1900
47	6200	21900	16	3600	100	1900
48	9200	17200	11	1800	110	2200
49	8400	17500	12	2900	110	1600
50	8800	19300	15	2200	110	1900
51	7400	18900	17	3500	110	1400
52	5400	25300	11	3200	110	2400
53	6500	20700	16	3100	100	1700
54	7100	18400	14	3800	100	1900
SPECIES = STIPA COMATA (NEEDLE AND THREAD)						
1	1300	15600	15	900	60	1400
2	1900	15200	15	8500	80	1300
3	1400	16100	16	7800	40	1100
4	1500	17600	13	7800	50	1400
6	1500	16000	15	800	100	1600
7	1500	14500	17	800	70	1300
8	2200	16000	22	700	100	1100
9	1600	14500	16	900	80	1600
10	1200	13800	18	1000	40	1400
11	1200	16600	16	900	30	1500
13	1400	15800	21	700	30	1200
14	1300	15000	17	900	70	1600
15	1600	16400	16	8900	40	1400
16	1300	16000	17	800	100	1400
17	1600	15300	21	800	40	1500
18	1300	12100	22	800	60	1100
19	1300	12100	17	900	60	1200
20	1200	11100	17	800	50	1200
21	1200	12700	14	700	60	1100
22	1600	15700	23	800	100	1700

VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT					
	CA	K	MN	MG	NA	P
23	1600	14600	12	800	90	1500
24	1700	13500	29	800	50	1200
25	2000	13300	16	900	40	1500
26	1700	10700	17	900	50	900
27	1100	14400	17	800	80	1200
28	1100	14200	15	800	30	1400
29	1300	13400	16	800	40	1000
30	1300	13900	15	800	30	1100
31	1300	14900	18	800	70	1400
32	900	11500	12	800	40	1300
35	2000	9800	13	600	40	900
36	1400	12000	29	900	70	1400
38	1000	9600	13	600	30	900
39	1400	14200	18	800	80	1100
40	1100	13700	13	800	100	1300
42	1500	15300	17	900	60	1100
43	1300	14500	15	900	70	1300
49	1200	8800	10	800	10	800
50	1700	11500	19	600	30	1100
51	1300	9200	11	800	20	1000
52	1100	9200	12	700	30	1100
53	1100	8700	14	500	30	800
54	1200	9100	16	700	30	900
55	1300	15100	14	900	70	1300
56	1000	9300	16	600	30	1000
60	1300	12600	11	800	50	1100
61	1300	12200	12	800	70	1200
62	1200	10900	13	600	60	900
SPECIES = VICIA AMERICANA (VETCH)						
1	14000	19400	66	2900	80	2300
4	14700	20200	60	2800	60	2300
5	12600	22200	62	2900	80	2700
6	12800	21500	44	3100	70	2700
7	13900	19600	64	3000	60	2100
8	16500	17800	62	3400	80	2000
9	16000	20500	60	2800	120	2000
10	17200	17800	42	2600	110	2100
11	12600	22100	63	2300	100	2400
12	12500	22800	47	2300	130	2900
13	10900	22800	49	2600	150	2600
14	13800	19000	62	2800	140	2600
19	6400	16800	17	3000	110	2000
23	5800	19800	14	3200	110	2100
24	14200	22000	76	3100	800	2500

VEGETATION ELEMENT CONCENTRATIONS (PPM)

LOCATION NUMBER	ELEMENT					
	CA	K	MN	MG	NA	P
33	11000	21200	52	3100	900	1800
34	14800	23500	82	2200	100	2300
36	16800	18300	88	4000	120	2200